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OF

PRACTICAL THERAPEUTICS.

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VOL. I.—PART I.

WITH ILLUSTRATIONS.

EDINBURGH & LONDON:

YOUNG J. PENTLAND.

1892.

PREFACE.

THERE is an art as well as a science in Medicine, and all the labors of the distinguished investigators who have by their discoveries within a generation transformed etiology, symptomatology, pathology, and pharmacology would be of little benefit to mankind if the practitioner had not found their application in therapeutics. To the physician and his patient the treatment of a disease is the one essential subject of study to which all others are subservient. It is the art of healing which must be exercised, and he is the most successful who is most fully acquainted with all the resources and methods which bedside and laboratory experience have placed at his disposal.

It is, then, with the object of providing the practitioner of medicine with reliable and helpful information concerning the best and most recent methods of curing disease that this work has been undertaken. The advances made in all branches of medical learning during the last few years have rendered therapeutic measures increasingly rational and complete, yet the extraordinary number of remedial agents which have been brought forward leads to a feeling of uncertainty in the mind of the practitioner as to when and how he can best employ each one. Further than this, exaggerated statements concerning new remedies are so frequent that only the few who have the opportunity to try them all can form correct ideas of their respective values. For these reasons it seemed to the Editor that a SYSTEM OF THERAPEUTICS embodying the views of those best qualified to discuss the subject of the treatment of disease would prove most helpful, and he feels that he can point with pardonable pride to the list of distinguished contrib-

utors whose articles afford a complete presentation of the therapeutic methods of the day.

With a view to completeness, surgical therapeutics has been introduced in the discussion of those ailments where such interference is indispensable, but, except in a few instances, the consideration of major operations has been excluded.

PHILADELPHIA,

222 SO. FIFTEENTH STREET

October, 1891.

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GENERAL THERAPEUTIC CONSIDERATIONS.

By HORATIO C. WOOD, M. D., LL.D.

I HAVE found it somewhat difficult to decide the exact scope proper for a chapter which is to serve as the introduction to an elaborate encyclopædic work upon the Art of Treating Disease; but it has seemed to me that the questions which may with propriety be considered in such an introduction are—first, the different principles which underlie the modern Methods of Therapeutics, including a discussion of the way in which physicians have discovered the facts upon which these principles are based; second, Dosage; that is, the question of the amount of the remedies to be given, including the relative effects upon the human system of the same medicine in different doses, and the influences of idiosyncrasies or personal peculiarities, as well as of age, of sex, of habits of life, and other similar agencies, upon the action of medicine in various diseases; third, Rules for the Combination of Drugs which should govern the physician in combining medicines into prescriptions.

Therapeutic Methods.

There appear to my thought to be only four possible methods of Therapeutics: 1st, Empiricism; 2d, Treatment by some Law of Symptoms; 3d, Scientific Therapeutics; 4th, A combination of one or more of these three plans.

Empiricism.—The primeval method of treating disease was that which we now know by the name of Empiricism—a method that may be defined as the using of a certain remedy in a certain disease because it has seemed to do good in similar cases. From time to time, led by chance, by fanciful suggestions, by mental influences unrecognized by their subjects, men have given remedies innumerable and most diverse to persons suffering from disease, and when recovery has occurred it has been generally attributed to the remedy administered last. No substance so vile and disgusting, no procedure so violent and injurious, that it has not been empirically employed, while men have affirmed and reaffirmed its great value as a cure. It is true that careful obser-

tical truth and success to empirical treatment, but such method must remain, even after centuries of study, uncertain and unscientific.

Therapeutic Symptomatic Laws.—The constitution of the human mind naturally revolts against such unreasoning action as that of pure empiricism, and consequently from time to time, even in very early ages, alleged general therapeutic laws or theories have been promulgated. When it has so happened that such theory has led to practical success in some directions, the minds of men have often been subjugated by the appearance of truth. This is the explanation of the sway of the old doctrine of signatures, which taught that a remedy affects that organ which it resembles in appearance. Thus, the color of rhubarb led to its use in constipation, whilst that of aloes induced men to administer it in diseases of the liver. In either case the patient was often benefited, and the truth of the alleged law was proved to its votaries.

HOMŒOPATHY.—Of these mediæval dreams there is only one whose survival challenges our attention at the present time. This is the so-called Homœopathy, or Hahnemannism.[1] The essential doctrines of

[1] The question as to the causes of the survival of homœopathy is one of great interest. I believe the first successes of the practice were really due to the fact that the regular physicians of the day did much more harm than good, whilst the homœopathic practitioner, giving only infinitesimal doses, and thereby practically leaving his case alone, allowed Nature full scope. This explanation, however, does not apply to the present time. It seems to be true that homœopathy is everywhere now on the decline except in the United States, as is shown by the following statistics, whose accuracy has remained unchallenged, although they were published nearly two years ago:

Germany was the birthplace of Hahnemannism, but the Homœopathic Medical Directory, published in London, shows that in Germany there are only 218 homœopathic physicians. Recent official statistics prove that in Austria there are 7183 medical men, of whom only 118 claim any connection with homœopathy, and of these only 44 practise the system exclusively; there are none at all in the Italian districts, and but 19 in Vienna. The Homœopathic Directory already quoted shows that in 1875 there were in Great Britain and Ireland 269 homœopathic practitioners; in 1880 there were 275; in 1883, 260; and in 1889, 256—an actual decrease in the face of the enormous increase, not only of the general population, but also of the numbers of the regular profession.

For the remainder of Europe the homœopathic statistics are—Belgium, 41; France, 97; Denmark, 7; Russia, 71; Italy, 55; Portugal, 2; Spain, 131; Switzerland, 26. Therefore, according to the latest statistics, taken from homœopathic sources, there are on the continent of Europe 1022 practitioners of homœopathy—this in a population of at least three hundred millions of people! Surely a system which has attained such small proportions as this, and which is distinctly decreasing in its proportionate numbers, cannot be said to be on an ascending plane. It is very interesting to note that the largest proportion of homœopathic practitioners according to the population, on the continent of Europe, is to be found in Spain—the one country where the general level of education is the lowest.

In America, Hahnemannism is probably holding its own; the reasons for the difference in the two continents are probably multiple. In America individualism runs wildest riot; irregularities of all kinds in religion, philanthropy, and medicine flourish. More potent in promoting Hahnemannism in America, however, than the peculiarities

Hahnemann were originally three. The first of these taught that chronic disease is the result of a general poisoning of the system by a humor, which when it finds its way to the surface causes the itch. Microscopic investigation and the discovery of the itch insect long since gave a quietus to this theory. The second doctrine of homœopathy is that of so-called infinitesimal doses. This doctrine is not a simple affirmation of what every one knows to be true—namely, that certain substances are so active in their relations with the human organism that the least particle of them impresses that organism; nor is it a statement that all or any drugs in minute quantities exert an influence antagonistic to the effect which they produce when in large quantity.[1] The infinitesimal-dose theory, as propounded by Hahnemann, does inculcate that a substance like chalk, which is in large doses inert, becomes, under the influence of trituration and dilution,

of the people are the deficiencies of the regular profession, which grow out of the lack of legal control over entrance into medical practice: most potent of all factors, however, is the notorious fact that the American homœopath does not practise homœopathy—a fact which our readers may find abundantly proven, not only by the testimony of regular physicians who have watched the practice of homœopaths, but also by the resolution passed in 1878 by the New York Homœopathic Association, affirming, *inter alia*, "We shall exercise and defend the inviolable right of every educated physician to make use of any established principle in medical science, or any therapeutical fact founded on experiments and verified by experience, so far as in his individual judgment they shall tend to promote the welfare of those under his professional care;" and finally by the statements made during the last two or three years by prominent members of the New York Homœopathic Medical Society, who have publicly and repeatedly affirmed in the columns of the *New York Medical Times* that there are practically no homœopathic practitioners, and who, when contradicted, have proven that their contradictors themselves do not adhere to their professed belief.

Homœopathy has, in fact, practically ceased to exist. Certain practitioners of medicine, however, avail themselves of the value of the name as a trade-mark in order to deceive the public and obtain an advantage over their rivals. The time has, in my opinion, come when the regular physicians should no longer, by refusing to consult with homœopathic practitioners, recognize their separate existence. If such a practitioner desires a consultation, he in so doing publicly states that he is on the same platform as the man whom he wishes to consult with; and if consultations between homœopaths, so called, and regular physicians became frequent, in a short time it would be impossible longer to deceive the public. Moreover, the habit of truth-telling would have a very palpable effect upon the homœopathic doctors themselves. Self-respect would soon lead them to tell the truth at all times. In my opinion, the regular profession not only has it in its power, but owes it as a duty to itself and to the public, to announce once for all that homœopathy having ceased to exist, and there being no class of medical practitioners whose practice is based "upon exclusive dogma, the rejection of the accumulated experience of the profession, and of the aids actually furnished by anatomy, physiology, pathology, and organic chemistry," therefore that every physician is at liberty to consult with whomsoever he pleases. By doing this the American Medical Association and other similar representative bodies would simply leave it to the individual doctors to consult when they wished to, but would not take away the right of any man to refuse consultation with an individual on the ground that he was a hypocrite or otherwise immoral.

[1] For discussion of this doctrine in detail, see "Dosage."

possessed of intensely active properties, as though there were liberated from it a spirit of healing which had been imprisoned in its material grossness. More than this, Hahnemann taught that it was possible by the mere violence of the trituration to potentize almost to infinity. In his *Lesser Writings* he says: "If we wish, for example, to attenuate a drop of the juice of sundew to the thirtieth degree, but shake each of the bottles with twenty or more succussions from a powerful arm in the hand of which the bottle is held,—in that case this medicine which I have discovered, the specific remedy for the frightful epidemic, whooping cough of children, will have become so powerful in the fifteenth attenuation (spiritualized) that a drop of it given in a teaspoonful of water would endanger the life of such child; whereas, if each dilution bottle were shaken but twice (with two strokes of the arm), and prepared in this manner up to the thirtieth attenuation, a sugar globule, the size of a poppy-seed, moistened with the last attenuation, cures this terrible disease (whooping cough) with this single dose, without endangering the health of the child in the slightest degree." In other words, Hahnemann taught that the activity of a medicine depends upon the number of times it had been shaken, and that medical inertness by excessive shaking may become converted into almightiness. Remembering the numbers of the followers of Hahnemann, surely the bitterness of Carlyle, when he says, "Where ten men are gathered together there are nine fools," seems justified.

It is the third doctrine of Hahnemann which has been and still is the rallying-point of his followers, and which is claimed to be the fundamental truth of his teachings; this is the so-called law of *similia similibus curantur*, in accordance with which a symptom produced by a disease is to be cured by a small dose of a remedy which, when given freely to a healthy man, will cause the same symptom. Strange, is it not, that this alleged law, which has made immortal the name of Hahnemann, was not originally framed by him, but is plainly stated in the works of that really great man—Hippocrates? For two thousand three hundred years this generalization has survived; it must possess some peculiar vitality, some measure of truth, and I myself believe that as a rule of practice it will at times lead to a good result. As illustrating the subject let me suppose a case of vomiting. Ipecacuanha when given in large doses will cause vomiting, but under certain circumstances when administered in minute quantity it will relieve vomiting. Witnessing such administration and such triumph, the bystander cries, "Great is *similia similibus curantur*, and Hahnemann is its prophet!" But a second case of vomiting appears which is increased by ipecacuanha and is relieved by opium, which does not vomit when given to the normal man in large doses, but makes him insusceptible to the action of emetics. Now the upholder of the doctrine of *dissimilia dis-*

similibus curantur cries, "Behold, I have the truth : the remedy which produces the opposite to the symptom is the remedy to relieve the symptom."

It is plain that neither in homœopathy nor in allopathy, neither in the doctrine of similars nor in the doctrine of dissimilars, is there the whole truth. A law of nature has no exception, and if exceptions be found to an alleged law, it is plain that the law is only an allegation and not a reality. If we were to find that at times weight disappears, that objects not under the influence of some opposing force or resistance fail to fall to the earth, then we would know that the Newtonian generalization of the attraction of gravity was not a law of nature. Neither allopathic nor homœopathic doctrines are laws; they are mere expressions of coincidences, each of them base coin gilded with just sufficient of truth to pass current with the ignorant and unwary. Symptoms are the mere surface play of disease, marking only with great uncertainty the currents, whirlpools, and rocks that lie hidden far underneath. Symptoms apparently the same may be the outcome of entirely different bodily conditions. Any system of treatment based directly and immediately upon symptoms must be untrue. It is not possible to find any therapeutic law which shall directly relate symptoms to remedies, and enable the practitioner in ease and ignorance to combat disease.

Scientific Method.—The third possible method of treating disease may well be spoken of as the scientific method. In a few words it may be described as being based upon a knowledge of what it is necessary to do in disease; an acquaintance with the power of the forces at hand; and an application, by the ordinary processes of reasoning, of such forces to the needs of the occasion. Unfortunately, we are at present unable thoroughly to carry out these scientific methods in therapeutics, because our knowledge of the disease-processes and our knowledge of the forces at command are each imperfect. Sometimes it may be the fault of the therapeutist, but more often I believe that the difficulty lies with the pathologist and the student of the natural history of the disease. We cannot explain how salicylic acid does good in rheumatism or how mercury does good in syphilis, because we have no knowledge of the essential nature of rheumatism or of syphilis. Every advance of pathology is rapidly followed by a corresponding advance in therapeutics. The powers of quinine in malaria were recognized many years ago by the therapeutist, but not until the pathologist discovered that malarial disease is due to the presence of an organism could the therapeutist know that quinine cures malaria by killing this organism. The discoverers of the influence of bacteria upon the human organization were followed almost at once by therapeutists who pointed out the brilliant results of disinfection and of antisepsis.

In any attempt at the creation of a scientific therapeutic system the

foundations must first be laid by an elaborate, exhaustive study of the natural history of disease when left to itself. For the purposes of discussion, and indeed of practical therapeutics, this study may be considered under four headings: first, the cause of the disease under study; second, the course and the result of the disease; third, how in fatal cases the result is brought about; fourth, the basal conditions which underlie the symptoms of the disease.

INDICATION.—Before, however, taking up these points seriatim, and showing their relations to the treatment of individual cases, it is necessary to define one term which is much employed by writers on therapeusis. The term "indication" is used by the therapeutist as equivalent to "the pointing of Nature for relief." Thus, a broken bone—that is, the removal of the internal support of the limb—indicates the use of splints, or, in other words, of external support; and constipation, or retention of fæces, indicates the use of a purgative which shall cause expulsion of the retained material. These are very simple examples, but in many cases the indications are discovered with much more difficulty, and the practical success of the physician will often depend upon his skill in reading them. In many instances the indication is not for a single remedy, but for several, which by acting together will produce a combined result not obtainable through the action of one of them.

Cause.—In studying the cause of an existing disorder for therapeutic purposes, it is first necessary to decide whether such cause has already ceased to act, or whether it is still existent and persistent in its influence. When the cause has been a fleeting one, no indications exist in regard to it; when the cause persists, however, the indication is for the removal of the cause. Very often we have no power, especially in acute disease, to fulfil this indication; but when we can accomplish the removal of the cause, then are we most successful as therapeutists.

Chronic diseases are frequently produced by improper habits of life, and the alteration of such habits is most urgently demanded. Alcoholism and chronic lead-poisoning are further instances of affections in which the immediate removal of the cause—first, by the prevention of the absorption into the body of more of the poison; second, by the elimination from the body of all that therein exists—is most imperative. Again, when we disinfect a wound, destroy a malarial organism by quinine, or kill a tape-worm by kooso we are carrying out the indication for the removal of the cause.

Course.—To the therapeutist a knowledge of the course of any disease, whether its continuance is definite or indefinite, whether its tendencies are toward health or toward death, is vital. Very rarely can an acute disease which has a definite course be arrested or put aside by any therapeutic measure; and in such cases there is a strong nega-

tive indication for the withholding of any attempt to arrest the disease. Active interference will, under such circumstances, usually do harm. This is especially true when the natural tendency of the disease is toward recovery. When, however, the tendency of the disorder is very strongly toward death, the arrest, if possible, must be had at all hazards. Thus, in a case of malignant ulcer or of hospital gangrene or of cancer the overwhelming indication is to remove the affected part, even if it can be done only at a considerable risk.

Method of Death.—When, especially in an acute disease, a fatal result sometimes occurs, it is a matter of the gravest importance to decide the way in which such result is produced, so that if possible it may be warded off. Thus, in typhoid fever we know that death is usually produced by exhaustion; hence the indication throughout an attack of typhoid fever is to combat exhaustion by absolute rest, by proper feeding, and by moderate stimulation. We know also that the fatal result may be produced by a local ulceration, and be greatly aided by excessive diarrhœa; hence the indication to soothe irritation and arrest excessive secretion by careful regulation of the diet and by the use of properly-selected local sedatives. Again, in typhoid fever the exhaustion may be greatly increased by changes in the tissues produced by an excessively high temperature; hence the indication for the use of antipyretics and external cold, it being remembered that these agents are not to be employed in a routine manner in all stages or even in every case of the disease, but are to be used simply to meet one indication as it arises; that is, to keep down the excessive heat.

To take a second example of the way in which indications are to be drawn from studies of disease: during the forming stage of a sthenic pneumonia there is a local vaso-motor paralysis in the affected lung, with a great excess of blood in the part, and the indication is, if possible, to withdraw blood from the lung. For this purpose large doses of a remedy which will quiet the excited heart-action, and at the same time paralyze the general vaso-motor system, are indicated. Such a drug is found in veratrum viride. Under its influence the heart-force is greatly reduced, and, what is more important, the widespread dilatation of the vessels throughout the body equalizes the vaso-motor condition everywhere and causes the withdrawal of the blood from the congested lung. It must be remembered that the abdominal blood-vessels are so large that when thoroughly relaxed they are capable of holding the blood of the body, and when this relaxation is obtained in a forming pneumonia by the use of a drug the patient is, as it were, bled into his own vessels. The result obtained is similar to that formerly reached by venesection, without the exhaustion which venesection produced. On the other hand, if consolidation has occurred in a pneumonia, one grave danger is failure of power in the right side of the heart. Possibly one-sixth or one-

fourth of the blood-channels through the lungs are practically closed, and the work required of the right heart, in order that the blood may be forced through the narrowed space, is much beyond the norm; this, too, at a time when the heart is suffering from the exhaustion of a severe general illness. Under these circumstances a cardiac depressant would immensely increase the danger. Now the indication is for a cardiac stimulant—a drug which, like digitalis, shall quiet the heart (irritated by these excessive calls upon it), lengthen the diastole, so that the ventricle can thoroughly fill itself with blood, and finally so strengthen the systole as to enable the heart to force the blood through the narrowed channels in the lungs.

Basal Conditions.—In carrying out the indications which have been spoken of in the last paragraph the therapeutist is simply affording relief by the treatment of certain symptoms whose tendency it is to do harm. More important than these in most cases are those therapeutic measures which arise out of the correct understanding of the basal conditions of body which underlie the symptoms. The proper recognition of such conditions is, in individual cases, of the gravest importance and often of great difficulty. The real nature of the bodily state having been made out, it is generally easy to remedy it. Thus, in any given case of heart disease the diagnostic problem for the purposes of treatment is not as to whether this valve or that valve is diseased, or whether the heart-muscle is weaker or stronger than in health, but whether the normal relation between the heart-muscle and the work required of the organ is preserved. Thus, in a supposititious case the leakage in the valves may necessitate the putting out by the heart-muscles of twice the normal amount of force in order to maintain the balance of the circulation, and yet the heart-muscle has only been increased in its power one half. Under these circumstances, although there is an absolute hypertrophy of the cardiac muscle, the basal condition is one of cardiac weakness, because the increase of heart-power has not kept pace with the increase of heart-work. The absolute cardiac hypertrophy is in fact a relative cardiac weakness, and the indication is for a cardiac tonic and stimulant—an indication to be met by the use of digitalis or of some other similar drug.

To illustrate further the relations between basal conditions and treatment, let us consider cases in which the functional activity of an important organ is abated. Under these circumstances the diagnostician may find that all the nutritive supplies of the organ are less than normal. This being so, the indication is for a stimulant to nutritive activity. On the other hand, the diagnostician may find that functional activity is abated because the nutritive processes are in excessive activity, and then remedies which will soothe and quiet nutrition are demanded.

In interpreting any individual case of disease it must be borne in

mind that similar symptoms are produced by exactly opposite basal conditions. Thus, purging may be the outcome of intestinal paralysis or of intestinal irritation, whilst constipation may result from intestinal irritation or intestinal paralysis. An apoplectic unconsciousness may be due to arrest of circulation in the brain or to a sudden increase of blood in the brain. A furious delirium may result from exhaustion or may be a manifestation of a violent irritation of the cerebral cortex; and in like manner a convulsion may be produced by lack of power of the nerve-centres or may have its origin in centric irritation. If the temperature of the brain be lowered below the norm, as in heat-exhaustion, unconsciousness with muttering delirium is caused; whilst the excessive heating of the brain which occurs in thermic fever also often betrays itself by unconsciousness and muttering delirium.

In an individual case of disease the nature of the condition is to be recognized, not so much by a survey of the chief symptoms as by the careful consideration of these symptoms in connection with others which may seem of minor importance to the inexperienced, but which really mark the direction which the current takes. To discuss here in detail the subject of indications drawn from studies of the fundamental states in individual diseases would be out of place, but there are two conditions so similar in their manifestations, and so often mistaken, that it seems proper to say a word concerning them. These states are especially important, since they may exist in a single organ or in the whole body—*i. e.* they may be local or general. I refer to exhaustion and depression. In exhaustion power is wanting; in depression the power is preserved, but the system or organ is prevented from exercising it by the presence of some paralyzing agent. The strong man dying of starvation and the strong man tied with bonds illustrate the two conditions. In exhaustion help can only come through food and rest, and medicines are of value solely as they enable the system to get the rest or to appropriate the food. In depression food and rest are of subordinate importance, and it may well be that food shall really do harm, because the person is unable to digest. The indication is for a stimulant, for some medical agent that will overcome the action of the depressing presence.

Remedial Forces.—When the therapeutist has acquired the knowledge of the pointings of nature for relief in disease, he must next consider the forces which are at hand for the meeting of these indications. Prominent amongst these various curative forces are those embodied in medicinal substances, so that a study of the action of drugs upon the human organism in health and in disease is of the first importance. Such study, so far as the symptoms produced by drugs are concerned, may be made by administering to healthy men and women, in various but safe doses, the drugs which are to be tested, and by carefully observing the phenomena produced in accidental or intentional poison-

ing. In this way, however, we can only arrive at a knowledge of the symptoms produced by the medicinal agent, but when it comes to explaining these symptoms and to determining the exact method in which the drug acts, experiments are essential. In any science which is to be advanced by experiment the would-be investigator must have the power of varying the conditions of the experiments; otherwise no new points can be elicited. The physiologist cannot use man for the purpose of experiment; he must have an individual unit that can be sacrificed to the needs of science for the benefit of the human race. It is not only possible, but morally justifiable, to make these experiments upon the lower animals. As exemplifying the necessity of these experiments, let us suppose that the drug A slows the pulse. It may do so either by stimulating the inhibitory nerve or by a direct influence upon the heart-muscle or its contained ganglia. If we are confined to observations upon man, we can never determine in what way the drug slows the pulse. If, however, we are allowed to divide the pneumogastric or inhibitory nerves in the animal, the point can at once be decided. Or suppose the drug B causes convulsions. Are these convulsions spinal or cerebral? With man we can only infer; in the animal we can divide the spinal cord and give the drug, when, if the convulsions be cerebral, they will be arrested at the point of section of the cord, but if they be spinal they will occur throughout the entire body.

The value of direct studies upon the lower animals has been denied on the ground that drugs act differently upon man and the lower animals. Physically, man is certainly nothing more than a highly specialized animal, and it is inconceivable that his relations with the forces of the universe are altogether apart and different from those of less specialized animals. Nevertheless, it is true that many drugs do affect men differently from the way in which they act upon the lower animals. It is, however, true that there are differences among the lower animals in their relations to drug-forces. It is not possible, however, that these drug-forces are isolated from the rest of nature in being the subjects of caprice rather than of law, and it becomes the scientific therapeutist not to deny, but to seek out—not to say it is impossible to understand the relations of drugs to man and the lower animals, but to attempt to discover the laws which govern the apparent variations.

Enough of these laws are in sight to guide us in most cases. The first of these laws is that which I would call the *Law of Differentiation*—a law which is readily explained by stating that when an anatomical system is similar in its functions in different animals it is similar in its relations to drugs, but when its functions are differentiated, so also are its drug relations. Thus, in some animals the digestive system is

arranged for the digestion of vegetable food, in others for the assimilation of animal matters, and in man for the needs of an omnivore. Under such circumstances we see variations of the digestive system in its relations to drugs corresponding to the variations in structure and function. We can understand why elaterium, although it purges a man, fails to purge a dog. For this reason the greatest caution must be practised in using experiments made with drugs upon the digestive apparatus of the lower animals for the interpretation of their effects in man.

On the other hand, the function of the circulatory system is similar throughout Mammalia; and it is well known that veratrum viride, digitalis, and other drugs, which act especially upon the circulatory system, act upon the lower animals as they do upon man, function and drug relations in the circulatory system being alike uniform throughout all forms of animal life.

The second *law* is that of *Development*, by virtue of which when any anatomical system becomes more differentiated and developed it becomes more susceptible to the action of drug-forces. An exemplification of this law may be found in the action of opium throughout the animal kingdom. As is well known, this drug acts upon the frog almost as does strychnine, causing great spinal excitement and general tetanus, whilst in man its influence is especially noticeable upon the brain, causing sleep or stupor.

This difference of action has been one of those most harped upon as showing the hopelessness of the attempt to reason from the lower animals to man. If, however, the attention be directed, not to the two or three experiments at the extreme ends of vertebrate development, but to studies made upon the whole range of animal life, it will be found that there is a regular gradation of symptoms, the spinal manifestations becoming less pronounced and the cerebral symptoms becoming more marked as the scale of animal life is ascended. In the frog the spinal system seems to be proportionately more active than in almost any other animal; hence it is especially sensitive to the influence of opium. In the horse the brain and spinal cord are equally active and equally sensitive to the opium, and consequently the spinal and cerebral manifestations are about equal in opium-poisoning. In the dog the brain is more highly developed, and the cerebral symptoms of the poisoning begin to be more apparent; whilst in man the over-development of the brain makes it so susceptible to the drug that the cerebral symptoms surpass and overshadow the spinal phenomena.

The third *law* is that of *Acquired Habits*. It is with much reserve that I venture to suggest the correctness of the theory involved in this law. The object is to account for those cases in which certain drugs, especially certain narcotic drugs, have lost their influence upon various

species of animals. It is well known that the animal system becomes accustomed to the habitual use of vegetable narcotics, so that doses which in the normal individual produce severe symptoms can be taken with impunity. My present thought is that probably this temporary habitual influence has been acquired by successive generations until it has been permanently stamped upon the species, so that the drug has finally lost its influence not only upon the animal, but also upon its offspring. It is alleged that the Virginia deer can feed upon the tobacco-plant, and I have seen stated by apparently reliable authority that certain monkeys inhabiting the regions where the *Strychnos nux-vomica* grows are entirely insensitive to the influence of strychnine. I have frequently seen our domestic goats, haunting the purlieus of cities, eat with absolute impunity the stramonium-plant.

In stating these generalizations, which I have ventured to call laws, it is not presumed that they cover the whole field or enable us to explain every case of variation in the effects of remedies on various individuals. Whatever contradictions may appear to arise in the results obtained by experiments, it is certain that animal experimentation affords our only possible means of investigating the physiological action of medicines. Whatever difficulties may beset this path, it is the only one which can lead us to a scientific therapeusis. In following it we must acknowledge, first, as a fundamental axiom, that no amount of experimentation can overthrow a clinical fact, although when a contradiction between experimental and bedside observation seems to arise, such contradiction challenges the correctness of the alleged clinical and experimental facts alike, and should lead to a careful re-examination. It was discovered by Traube that digitalis increases the blood-pressure in the lower animals, which led to a doubt of the correctness of the then general belief that digitalis acts upon man as a cardiac sedative, and finally to the recognition of the falsity of the clinical observation upon which such belief was founded. The field of vision of the experimenter must not be confined to one species or to one set of animals, but the whole series of animal life must in detail be passed in review; and I believe that almost invariably a complete study of the clinical and experimental evidence will reveal a beautiful concord—that concord between experimental and practical medicine which so often fails to appear, simply because we cannot fit together the fragments of truth in our possession.

In the last twenty years therapeutics has grown enormously toward scientific accuracy and in scientific methods, and each year witnesses marked progress. Nevertheless, we are still hampered by our ignorance—an ignorance which, as has already been stated, is more often in the region of pathology than that of therapeusis—and we are therefore forced at present to mingle science and empiricism; so that the

best therapeutics of the day, the therapeutics which is to be inculcated in the present System, is a *mixture of science and empiricism.*

Dosage.

By the term *dose* is meant the amount of a medicine which it is safe or proper to administer to a human being. The doses which are given in textbooks on therapeutics of necessity differ considerably from those used in practical medicine. It is, indeed, not intended that these given doses should be considered as fixed quantities, but as average amounts, which are to be departed from to suit the needs of the individual case. The maximum dose of the active remedies, as given by the textbook, is or ought to be the amount which will produce slight but distinct symptoms in a normal individual: such dose is sometimes termed the Physiological Dose. Doses are sometimes spoken of as the Single, the Continuous, and the Daily Dose. The Single Dose is that which it is proper to administer at one time, without expectation of repetition. It is usually given for the purpose of producing an immediate effect, as in the administration of a purgative. The Continuous Dose is that which it is proper to administer when the remedy is to be repeated at shorter or longer intervals for the purpose of maintaining an impression upon the system. The whole amount of the added continuous doses, as given in the twenty-four hours, is spoken of as the Daily Dose. In administering remedies to make a prolonged impression it must be remembered that the effects, and especially the length of time which each dose acts, vary greatly according to the nature of the remedy, and especially according to its relations with the excretive glands. The vegetable alkaloids are usually rapidly absorbed and rapidly eliminated or destroyed, so that each dose acts promptly and there is no accumulation of the drug in the system. On the other hand, those vegetable remedies which are dependent for their activity upon glucosides commonly yield their active principles slowly to absorption; but when these principles are once taken into the body they are eliminated with great slowness, hence the liability of remedies of this class to have the so-called cumulative action—*i. e.* to exert, after long continuous use without much apparent effect, a sudden overwhelming influence. As an example of a substance possessing this cumulative action may be mentioned digitalis. It has been repeatedly denied of late years that this drug ever acts in this way, but I know from personal experience that it does do so. Thus, in a case in which it had been long administered in hopes of aiding in the absorption of a pleuritic effusion no effects were apparent until a certain Sunday, when the pulse fell from about 100 to 85. Although the drug was immediately withdrawn, the progressive fall of the pulse-rate continued, so that by Wednesday the heart beat only forty times a minute, and not until Friday did the

pulse-rate begin to rise toward the normal. The cumulative action of digitalis is especially liable to occur when the drug fails to increase the activity of the kidneys; that is, when it fails to be eliminated. A sudden cumulative action of digitalis is sometimes produced by a sudden absorption of it from the tissues where it has been stored. Thus, I have known cases in which digitalis had been given for a length of time for the relief of heart symptoms, in which "tapping" was finally resorted to on account of the excessive ascites, with the result that a day or two after the tapping there was an explosion of digitalis-poisoning. The explanation of this is very simple: the withdrawal of the pressure upon the outside of the abdominal vessels caused in them general relaxation, which relaxation in turn lowered the general arterial pressure throughout the whole system, and thereby favored absorption of the serum lying in the various tissues of the body. This serous dropsical fluid was, however, saturated with digitalis that had been gradually stored up in it, so that with its absorption there was a sudden pouring of digitalis into the blood, and as a necessary result an excessive action of digitalis; for it must be remembered that it is not the drug which is in the tissues of the body, but the drug which is in the blood-vessels, that influences the heart and nervous system.

Mineral substances are more apt to accumulate in the body than are those belonging to the vegetable kingdom. Arsenic, mercury, lead, and various other minerals are well known to be deposited in the tissues. Other mineral substances which do not yield insoluble compounds in the body, and are not therefore deposited in bone, muscle, or nerve-centres, nevertheless may accumulate in the various liquids and tissues, although after the cessation of their administration they are more or less slowly removed. Thus, when the bromides are given continuously they gradually saturate the system, and produce the so-called "bromism," a condition which rapidly disappears on abstinence from the remedy, because the loose, soluble bromide compound is rapidly taken up by the blood and thrown off by the kidneys. The effects of lead-poisoning, on the other hand, are permanent, because the insoluble lead compound remains in the tissues.

A knowledge of the relations between absorption and elimination in affecting the effects of remedies is of the gravest importance in practical medicine, and it is extraordinary that these relations are so often lost sight of in the administration of drugs. The generalization which naturally follows immediately upon their consideration is that not only the size, but especially the frequency, of the dose must be adapted to the usual rate of absorption and elimination of each individual drug, as well as to the effects desired upon the system. The dose of a very fugacious agent ought to be given at very brief intervals, in order to have any steadiness of action. Yet how often is the whole matter for-

gotten! As an every-day example take an ordinary cold or mild bronchitis. Certainly in this affection a steady impression is desirable. Nevertheless, for the relief of a cough hydrocyanic acid is often given in a mixture every three or four hours. The influence of this acid is so fugacious that, as is well known, the symptoms caused by a toxic dose usually disappear within an hour. The ordinary dose of hydrocyanic acid is so small as not to have any perceptible physiological action. If a very powerful toxic influence is over in an hour, how long will an imperceptible, intangible, and probably non-existing influence last? It is hardly necessary to point out in more detail the utter folly of giving the acid in the way commonly indulged in. The matter is much more serious in the employment of remedies which have more positive influence upon the system than has hydrocyanic acid in therapeutic doses. The action of an ammoniacal salt is almost as fugacious as that of hydrocyanic acid, yet how often are ammoniacal remedies given in large doses at intervals of three, four, or even five hours!

This habit of giving at short intervals powerful remedies whose influence is short lived I have sometimes in my lectures called the "*kangaroo*" *method*, the name being suggested by the thought that such treatment consists in a series of great "hops"—a stimulation or depression of the system or organ, as the case may be, in one hour, to let it drop back the next to the old level.

When absorption and elimination of a drug take place slowly, the intervals between administration may well be lengthened. Thus, it is rarely necessary to give digitalis oftener than once in four hours. Again, when the full influence of the drug is only reached by bringing about an accumulation of it in the system, the intervals may be very long. As an example a case of epilepsy may be taken in which mild bromism has been produced. In such a case, from the bromide pool, to use a metaphor, in the system there is a constant slight leakage throughout the whole twenty-four hours by elimination, but the loss from the pool can as well be made up by additions by two doses in the twenty-four hours as by doses at shorter intervals, because the single dose is so small in proportion to the mass in the system that its immediate influence in raising the surface of the pool is not perceptible. The constant taking of medicine is to most people very disagreeable, and in epilepsy it is wisest to avoid the annoyance of the frequent repetition of the dose.

During the last few years an attempt has been made to establish a therapeutic law or guiding principle, which, although not identical with the law of "similars," as inculcated by Hahnemann, has close relation with it. This alleged law may be formulated as follows: All medicinal substances, when given in small doses, produce results precisely opposite to those which they cause when administered in large doses. In my opinion, the only novelty that there is about this allegation is in

the absoluteness and dogmatism with which it has been made. It has been known from time immemorial that the symptoms produced by small doses of *certain* drugs, especially by those drugs which we consider stimulants, are the reverse of the symptoms caused by large doses of the same drugs. It cannot be denied that ammonia, alcohol, and ether excite cardiac action—*i. e.* increase functional activity—when in moderate amount, although when in large quantities they arrest the heart in diastole—*i. e.* paralyze functional activity. On the other hand, there is not the shadow of proof as yet that *all* drugs act differently in large and small doses. Aconite, so far as we know, depresses the heart-muscle whether in small or large amount, whilst digitalis augments the functional power of the heart-muscle until at last cardiac arrest takes place in spasm. As did Hahnemann, so here also does it seem to me that these new therapeutic generalizers have mistaken a partial truth for a whole truth, and made a generalization based upon symptoms instead of upon bodily conditions. There must be some differences between the action of a remedy which, like ammonia, first increases and then decreases functional activity, and one which, like digitalis, creates a spasm which abides to death; and it may well be that certain forms of functional excitement naturally end in paralysis without there being change of kind in the condition of the affected part.

The old doctrine that excess of stimulation ends in arrest of function affords a wiser way of putting the matter than the new method of statement, because what is true of drugs is also true of forces. A moderate heat stimulates activity; an intense heat paralyzes it. A feeble electrical current contracts the muscle; a sufficiently powerful one paralyzes it permanently. It would seem, however, that even this generalization is not correct, for there appear to be stimulants which in excess fail to paralyze.

I do not think it necessary to occupy more space with a discussion of this matter. We are not near enough to the knowledge of the real methods of action of drugs to make any fundamental deductions; all attempts to build up a system of therapeutics upon such more than doubtful generalization must remain for a long time to come futile. The practical therapeutist must, however, always keep in remembrance the fact that many remedies act differently in different doses, and must accordingly apply his knowledge in treating individual cases of disease. The different actions of different doses are sometimes seemingly antagonistic, but not rarely they are for practical purpose entirely different in kind, having no apparent relations. Thus, as is well known, a small dose of alcohol acts chiefly as a digestant when given with food, enabling the stomach more readily to assimilate; a larger dose of alcohol acts as a general stimulant; an overwhelming dose as a paralyzant both of the nervous and circulatory systems. In the same way, a small

dose of quinine may be of service as a stimulant to the stomach and to the general nervous system; in a larger dose the alkaloid is given as an antiperiodic for the purpose of arresting malarial disease, whilst by some therapeutists enormous doses have been administered for the purpose of depressing the circulation and the general system, and thereby obtaining relief in inflammatory conditions.

Physical State of Patient.

The physical states of patients, as well as their environments, so greatly influence both the effects of medicine and the size of the dose proper to be employed that it seems necessary here to devote some pages to their consideration. For the purposes of discussion these general conditions are best arranged under the headings: Age and Sex; Time and Method of Administration; Emotion; Temperament; Idiosyncrasies; Climate and Habits of Life; Disease.

Age and Sex.—For the purposes of physiological experimentation, especially when it is intended to determine the minimum fatal dose of a remedy, great accuracy of dosage is required. It is evident that in an animal weighing one hundred pounds the amount of blood, and consequently the dilution of a given dose of a drug after absorption, must be greatly in excess of what it is in an animal weighing ten pounds. Domestic animals, of the same breed, often differ extraordinarily in their size. For these and other similar reasons the physiologist always gives the dose of a drug as so much per pound.

In human medicine we do not expect such extreme accuracy of dosage, and the difference of weight between individuals is not so great. Consequently, the therapeutist very rarely speaks of the dose per pound. At the same time, in the case of extremely small or extremely large persons the dose should be altered from the average standard. The difference between the weight of the child and the adult is very great. Partly from this fact, and partly because some portions of the organization of the young are more susceptible than they are in adult life, the necessity arises for a very careful adjustment of the dose in the cases of children. The late Professor Clarke proposed a plan according to which the dose is to be graded by the weight of the child. One hundred and fifty pounds was taken as the weight of an average human adult, and in order to obtain the fractional dose this number served for the denominator of a fraction whose numerator corresponded to the weight of the child in avoirdupois pounds. Thus, the formula for a child fifty pounds in weight would be $\frac{50}{150}$ or one-third of the dose for the adult. A theoretic objection to this rule is that though it attempts scientific accuracy, it makes no allowance for the difference in susceptibility in the different anatomical systems in youth and in age. A more important practical difficulty is found in

the fact that very frequently the physician does not accurately know the weight of the child. In actual practice the arbitrary rule of Dr. Young is the one which I think is almost universally adopted in this country and in England. According to this rule, the fraction for the child is found by the formula of $\frac{\text{age}}{\text{age} + 12}$. Thus, if a child were four years old, the proper dose would be $\frac{4}{4 + 12} = \frac{1}{4}$th of the adult dose. In the formula of Cowling, still sometimes used, the fraction is, $\frac{\text{age next birthday}}{24}$; according to this, the dose for a child approaching four years of age should be $\frac{4}{24} = \frac{1}{6}$ of the dose of the adult.

It will be seen that these formulas give quite different results. I think that that of Dr. Young is, on the whole, the more accurate, but in applying it the practitioner must remember that it is an arbitrary rule with numerous exceptions. In the case of purgatives the dose should usually exceed that allotted by the Young rule. Thus, for a child four years old a dessertspoonful of castor oil would not be an over-dose, whereas the dose should be a teaspoonful according to the rule. On the other hand, with remedies which powerfully affect the nervous system the dose should usually be much below that given by Young. Thus, in a child two years old the fraction by Young's rule would be $\frac{1}{7}$, which would give as the ordinary dose of laudanum 4 drops, an amount certainly dangerous.

As old age is approached the human nervous system usually becomes less sensitive, and hence feels less acutely the effects of narcotics; hence, morphine and similar drugs can be used more freely than during middle life. On the other hand, depressing influences are less stoutly resisted, and hence the use, and especially the doses, of all depressing drugs should be more and more restricted. During progressive failure of the physical powers stimulants are very well borne, and should be employed more freely than in earlier life.

In regard to the influence of sex upon dosage, it is hardly necessary to point out that woman is not only smaller, but, at least in this country, more sensitive than man, and that therefore the proper doses for her, especially of depressing or perturbating medicines, are smaller than for man; also, that the dominating influence of her sexual life must never be lost sight of. During menstruation it is often well to suspend active medication, and always imperative to avoid disturbing the general system without due cause. During pregnancy emetics are of course strongly contraindicated, as are also remedies which have a distinct tendency either to irritate the kidneys or to depress the vital forces.

Time and Method of Administration.—The time and method of

administration of remedies are chiefly of importance, because by a knowledge of these facts we can gain information as to the rate at which the remedies are absorbed and as to the influence which they exert upon the tissues through which they find entrance into the body. As portals for the admission of medicines into the human body physicians have the stomach, the rectum, the lungs, the skin, and the cellular tissues under the skin.

The most general rule for the administration of a medicine is that the drug must be given by the mouth, unless obvious reasons exist for not doing so; so that the dose given in the textbooks is that for use by this entrance.

The solvent powers of the gastric and intestinal juices are so great that few medicinal substances refuse to yield to them.

The form in which the remedy is administered has much to do with the rapidity of its absorption. Usually, but not always, a substance in solution or a soluble preparation is more rapidly taken up in the stomach than an insoluble one. Certain solutions are, however, precipitated by the gastric juices; as examples may be mentioned a number of the soluble salts of iron. If the active principle be in solution, it will commonly be more rapidly absorbed when the stomach is empty than when the viscus has food in it; if, however, the drug must be dissolved in the stomach, it may well happen that absorption takes place best after a meal. Medicines which are locally irritant are best given when the stomach is full, so that they may be diffused through the mass of food, and not come in contact with the mucous membranes in concentrated form. On the other hand, if it be desired to affect the stomach locally, it is better to give the remedy when the viscus is empty. Thus, in chronic inflammation of the stomach nitrate of silver should be administered half an hour before meals; but when, as in epilepsy, the expectation is to affect the general system, the silver salt ought to be exhibited after meals. When the mucous membrane of the intestines is to be reached, it is commonly better to give the remedy at a time when the natural flow of partly digested food from the stomach into the intestines is in fullest activity. Thus, in gastric irritation the subnitrate of bismuth should be administered half an hour before meals; in intestinal irritation at from one to two hours after meals.

When *rectal injections* are given the fact should be remembered that the general office of the rectum is to throw out rather than to absorb, and that its juices are alkaline in their reaction and have very feeble solvent powers. Medicines are therefore taken up from the rectum with difficulty and great slowness, and when rapidity of effect is desired this channel should not be employed. If it require half an hour for the absorption of a certain alkaloidal salt from the stomach, about fifty minutes should be allowed for absorption from the rectum. It has

been the habit of many physicians to make the rectal dose of medicine one-half greater than the dose by the mouth. The chief value of rectal medication is for the purpose of influencing the rectum itself or the neighboring organs. The preparation of the remedy used must be small in bulk and free from irritant properties, otherwise it is rapidly rejected.

When the remedy is suitable and properly prepared for exhibition by *hypodermic injection*, it is absorbed much more rapidly than when given by the stomach. If half an hour be required for the gastric absorption of a medicinal principle, fifteen minutes will probably suffice for absorption through the cellular tissue. The hypodermic dose may be set down as commonly about 20 per cent. less than the stomach dose. This difference arises partly from the greater rapidity of the absorption, but probably also, in part, because alkaloidal salts are to some extent destroyed in the liver, so that only a portion of the remedy reaches the general system after its absorption from the stomach.

There are so many objections to the hypodermic method of medication that it should not be employed unless for obvious reasons. There is always a possible danger of throwing the entire dose into a vein, and consequently into the right side of the heart in a concentrated form. I once injected one-sixth of a grain of morphine into the arm of a woman, who within two minutes fell back unconscious. The jaw dropped, the respiration ceased, and for a time I thought I had killed my patient. Moreover, local inflammations, abscesses, and ulcerations have resulted from hypodermic injections in innumerable cases. I believe that in a very large proportion of these instances, however, the local trouble has been due to an unclean hypodermic syringe. It is essential that the hypodermic solution and the syringe with its needle be thoroughly aseptic. It must also be remembered that the cellular juices are distinctly alkaline, and that therefore in the use of substances which, like quinine salts, are insoluble in alkaline solutions care must be taken to have the solution distinctly acid: vegetable acids are usually preferable to the mineral acids. Local inflammations are also much less apt to arise if the solutions are thrust boldly and deeply into the part, since when the injection is practised directly under the skin that membrane may be torn from its attachments sufficiently to interfere with its circulation. Distilled—or, better, recently-boiled—water should commonly be used as the basis of a hypodermic solution. Unboiled well, river, or other natural water must never be accepted, but alcohol is in some cases permissible. Thus, we have no concentrated watery preparation of digitalis, and when urgency exists the tincture may be employed. Ten minims of it will usually not cause serious local trouble. Nevertheless, it is only on rare occasions that the physician is justified in using any other drugs than alkaloidal salts hypodermically. Mercurial injections have,

it is true, been much praetised on the eontinent of Europe, but I have seen death result from the local sloughing produeed by ealomel injections whieh had been given with the strictest attention to the minutest rules laid down by the highest European advoeates.

The *endermic method*, or the absorption of drugs through the skin from baths, takes place with such slowness and feebleness that we eannot use this method for the purpose of impressing the general system. When, however, the skin is anointed with a fatty material containing a medieinal substance, absorption to an appreeiable extent may oeeur; henee, inunetions, or rubbing with fatty preparations of active drugs, have been largely praetised for the purpose of affeeting the whole organism. It is important when inunctions are to be praetised that the fatty material ehosen be sueh as is best adapted to the purpose. Four substanees are in eommon use: lanolin, eosmoline, ordinary fats, and more or less impure oleic aeid.

Lanolin is ehiefly a sebaeeous substanee, eontaining a large percentage of insoluble eholesterin; it is a natural fatty material that is thrown out for the purpose of rendering the hair of the animal soft. It is really of the nature of an excretion, whieh is not meant by nature to be absorbed, but to remain on the surface of the skin as a soothing, non-irritating emollient whieh shall render the skin and hair more pliable. Whilst, therefore, it is well adapted to be the base of an ointment intended to aet loeally on the skin, it is not a suitable vehiele when absorption is desired. Cosmoline is a mineral substanee, the major part of whieh is eomposed of paraffin, whieh is very insoluble and probably ineapable of absorption. Nevertheless, the more fluid oils whieh enter into the eomposition of eosmoline, and whieh probably are the solvents of the substanees, probably aid the absorption of the drugs into the system; and eertainly a cosmoline ointment is eapable of impressing the organism. Experience, as well as *a priori* reasoning, indieates, however, that as a vehiele when absorption is desired eosmoline is inferior to the natural animal fats. The old objections to these latter substances are their liability to beeome rancid and the sense of "dirtiness" whieh attends their use. It is espeeially on the seore of cleanliness that solutions of active prineiples in fatty aeids have been praised under the term of oleates, and it also has been claimed for them that they aet more promptly than true ointments. The efficiency of these oleates cannot be gainsaid, but they are more expensive than ointments, and have seemed to me to be more irritating to the skin; so that in my own practiee I have gone back to the older preparations.

The use of the skin as a portal of entrance to the body is, after all, only rarely proper. Absorption takes place so slowly, and with so much uneertainty, that it is not possible to have any coneeption whatever of dosage. The only proof in a given case that absorption

has taken place is the production of the physiological action of the remedy.

Almost the sole advantage attached to the exhibition of medicines by the skin is the avoidance of the local action of the drug used upon the internal organs; but sometimes when it is desired to impress the system as rapidly as possible the drug is simultaneously given by the mouth, by the skin, and by the rectum.

Endermic medication is at present confined almost exclusively to the use of mercurials. In exhibiting these remedies it is essential to remember that they are locally irritant, and that a definite plan of administration must be arranged, so that no one portion of the surface of the body shall have the ointment applied to it two days in succession. It must also be remembered that some portions of the skin absorb much more rapidly than others. The following is a working schedule: Sunday, left arm-pit; Monday, left flank and groin; Tuesday, inside of left thigh; Wednesday, inside of right thigh; Thursday, right flank and groin; Friday, right arm-pit. When inunctions are to be practised twice a day, the backs of the calves of the legs may be interpolated in this schedule.

The anatomical arrangement of the lungs is such as to offer an enormous amount of surface and a very easy entrance into the absorbents; consequently, these organs afford the most open portal to the system, for entrance through which, however, a substance must be in the form of gas or vapor The lungs are not only adapted for rapid absorption, but also for rapid elimination, so that a gas not only enters through them with absolute freedom, but also is thrown out with almost equal rapidity when fresh supplies are no longer furnished. In these facts is to be found the cause of the rapid development and the fugaciousness of surgical anæsthesia.

When it is desirable to impress the system for any length of time substances which are not easily vaporable, and which therefore are not easily eliminated from the lungs, must be employed. It is only in the crises of an acute disease, when an overwhelming, immediate impression is desired, that the physician avails himself of this method of administration.

Atomization, or the pulverization or breaking up into fine spray of water with some substance dissolved in it, is an important medicinal process. It is not, however, well adapted for internal general medication, and is used only in order to obtain a local influence upon the mucous membrane of the air-passages. When it is desired to reach the upper passages, the spray may be a coarse one; but the lungs themselves can be affected only by a very fine spray thrown into them in large volumes during full inspiration.

Habits of Life, including Climate.—Whatever may be our belief

in regard to the Darwinian theory of creation, it is certain that the animal system adapts itself within certain limits to its environment, and that, therefore, habits of life have a profound influence upon the whole organism; and, as a further consequence, the relations of drugs to the individual are altered. Hard physical work, habitually kept up for years—especially when, as is generally the case, it is associated with habitual exposure to weather as well as to hardships of greater or less severity—produces a condition of the system in which disturbing influences are little felt until they become excessive in their power. On the other hand, refinement, luxury, and indolence naturally tend to the production of effeminacy and of a peculiar sensitiveness to disturbing agencies. The history of the human race everywhere teaches this lesson, and I am told by experienced veterinarians that it is almost as apparent in the lower animals, so that cart-horses and similar animals of low pedigree often continue to eat their oats whilst surgical operations are being performed on them which would make a thoroughbred racer scream with pain and plunge wildly about.

Any one who has passed through an apprenticeship in the wards of a great city hospital, chiefly given over to the care of the lowest orders of mankind, and gone out to practise amongst people belonging to the higher walks of life, must have learned the lesson that his customary doses frequently have to be reduced one-third, and even one-half, in order to meet the exigencies of his new class of patients.

Habits of life also modify the relations of the organism to drugs, in that they tend to the production of certain diseases. In malarial countries almost all diseases seem to require quinine. In hot climates depletion is very badly borne, and if we may believe recent statements even the relations of men and animals to anæsthetics are changed. In the moist, peculiar atmosphere of Japan rheumatism and neuralgia are extraordinarily rife; indeed, the tendency to the production of rheumatic diathesis is so intense that it is affirmed by high authority that even horses imported into Japan very commonly become disabled by rheumatic disease.

Among habits of life the constant use of certain drugs may well be considered as affecting treatment greatly. Especially must the practitioner be on his guard in respect to the effects of the habitual use of alcohol.

Doses of stimulants which would paralyze the ordinary individual make scarcely any impression upon the man who has long been used to taking a half pint of whiskey daily. Symptoms are so altered that in alcoholic subjects depressants often appear to be indicated when they are not, and even in the rare cases in which depletion really is demanded it is not safe suddenly to withdraw the daily dose of alcohol to which the subject has been long accustomed, and sometimes the best results are to

be reached by continuing the alcohol and at the same time exhibiting depressing remedies. In the presence of an acute disorder he would be a bold physician who would advise the breaking off of the opium habit. As is well known, it is always dangerous to withdraw opium abruptly from a patient who has long been accustomed to its use. The nervous system, which might have been able to right itself if a week or ten days is given to the withdrawal of the narcotic, not rarely falls into collapse upon an immediate withdrawal of its customary stimulus. Many physicians appear to forget the possibilities of a prenatal alcoholic or opium habit. Literature, however, shows that when the female opium victim brings forth a child, such offspring is prone within forty-eight hours to die of an apparently causeless collapse. The real cause of such collapse is, however, the need of opium. The child in the first few hours finds itself not only struggling with the new conditions of life, but also totally deprived of its nerve-stimulant, and it dies when its life might have been saved by doses of laudanum perhaps sufficiently large to kill an ordinary infant.

The power which the human system has of habituating itself to the influence of certain drugs is remarkable, especially when contrasted with the fact that the prolonged exhibition of certain other drugs seems to render the human frame more susceptible to their influences. The strangeness of the fact becomes still more apparent when it is recognized that even with a single individual drug like the iodide of potassium the system in some persons grows accustomed to its influence, whilst in other cases there is a gradual lessening of toleration, until finally the remedy cannot be given except in the most minute dose.

The laws which govern these peculiarities are at present unknown. It would seem, however, that vegetable drugs are more usually tolerated than mineral substances, and that in those cases in which the system becomes more sensitive to the action of a remedy there is usually either an accumulation of the drug in the body, or else the production of some local inflammation which is at the bottom of the intolerance.

It is often necessary for the physician to bear in mind the benumbing influence of "drug habit" in prescribing for cases which are essentially chronic. In such cases a drug which at first acts, it may be, most happily, often by and by loses its control. When under these circumstances the remedy is intermitted for a length of time, the sensitiveness of the organism to its influence usually returns. For these reasons the prescriber should substitute from time to time one remedy for another of the same class. Thus, in atonic dyspepsia after three or four weeks the extract of quassia may be replaced by the extract of gentian, and that in turn by the extract of chiretta, and so on; in chronic heart-failure, usually *before* digitalis has sensibly begun to lose its control, caffeine should be given in its place, and then strophanthus or adonidin may

be essayed, or digitalis itself given again; in chronic constipation the salines may be followed by a combination of aloes, belladonna, and strychnine, and this in time should give way to rhubarb and colocynth or cascara sagrada. Thus, one after the other may the changes be carried out until the end of the chapter.

Emotions.—There is a school of philosophers, numbering among them some of the world's greatest scientists, who affirm that mental conditions are symbols of consciousness of the changes which take place automatically in the organism; that we are conscious automatons; that feelings can have no causal efficacy, produce no functional excitement of the nervous system, and no changes either in action or in structure; that they are, as Mr. Hodgson says, laid upon the surface, having no more influence upon the part below than the superficial colors upon the stone of the mosaic, consciousness itself being nothing more or less than a sort of aura or collateral function of the nervous system.

As a student of psychology I believe that these ideas rest upon pure dogmatism and assumption, and as a practical physician I know that the therapeutist who acts upon such theories will fail in his treatment of disease; and I suppose that to practical men the strongest proof of the truth or falsity of a theory is the practical results which follow its being brought to the test of every-day life. According to this theory, emotions are without influence, being themselves purely results of nervous excitement, mere reflexes of peripheral stimuli. There is no reason for believing that an emotion can exist apart from consciousness, and every physician must know that the waves of unusual emotional excitement are capable of profoundly influencing the nervous system for evil. I have seen the fright produced by a loud clap of thunder cause a chorea which lasted for many months. Abundance of cases are on record in which an absolutely hopeless intellectual paralysis has been produced by the fright of a few minutes. Thus in a recorded case a girl, ready and apt, suffered rape and was left for life a hopeless idiot.

Without going further into this subject, because it is more or less foreign to the matter in hand, it suffices to reiterate that emotions have power for evil in their influences on nerve-matter, and that they also have power for good. When a resident physician in the Philadelphia Hospital years ago, in charge of a large ward of women, I habitually used a solution labelled "Morphine" which contained none of that alkaloid, but just enough quinine to make it conform in taste to the knowledge of the habitués of the institution, and in three cases out of five it aided in bringing comfort and rest, as well as did the genuine morphine solution. Some time ago I gave to a patient, with very minute and emphatic instructions as to the method of use, a prescription for pills of bread. Several months after she came back to me and said, "Doc-

tor, why did you not give me that prescription sooner? It is the only thing that has reached my case, and I have had that prescription filled at the apothecary's for a number of my friends with extraordinary results."

The physician who fails to avail himself in disease of the "expectant attention" drops one of the most important articles out of his list of medicinal agencies. The history of quackery is full of lessons as to the truth of this. The innumerable certificates of the value of infinitesimal doses, and the successes of "Christian Science" and the "Faith Cure" in recent times, as well as the great relief afforded our grandfathers and grandmothers by Perkins's tractors, and the reputations of numerous charlatans,—all bear witness to the efficacy of faith as an agent of healing. Some years since there was in my employ a boy who had contracted malarial chills of a most obstinate variety, for which I myself had treated him through some months with great care, without preventing the occasional return of the paroxysms. Happening to have a medical friend well provided by nature with bald head, long beard, and solemn aspect, I had the boy taken by him into a partly darkened room and addressed in a very impressive manner, with the final statement that he would only have one chill more. The result coincided with the prophecy. After having been at Luys's Clinic in Paris, and watched the results obtained by hypnotism, I myself firmly believe that these results are the outcome of the effects of emotion upon the organism. The cures have been usually alleged by the believers in hypnotism as a therapeutic measure to be due to the suggestions made to the patients while in the hypnotic condition, and it has been asserted that these cures are proof that suggestions have an influence upon the nervous system without acting through the consciousness of the patient. I believe that the patient often does not remember the suggestions when he recovers consciousness, but it must be borne in mind that the whole atmosphere of the place in which Professor Luys receives his patients is heavy with faith, and the scene of the daily clinic itself most weird and impressive—one, two, three learned doctors, with grave countenance and studied mien, going about among a number of individuals, commanding them at will, putting them asleep one after another, until the room is full of quiet automatons, who marshal themselves at the will of the physicians. At the clinic I noticed two things: first, that the patients were those whose nervous systems would naturally be expected to be influenced by "expectant attention;" second, that not rarely the assistants, in the hurry of the morning, made very slight suggestions and perhaps failed to suggest at all. After my return home, in my own wards at the University Hospital, by hypnotism without suggestions I obtained cures of palsies of standing, of tremors resembling those of paralysis

agitans, and of other cases, some exactly simulating one or more of the most famous of Luys's cures. It appears to me that in the therapeutic history of hypnotism we have simply another example of the great influence of mind over matter. Tremors cease, convulsions fail to recur, and motion returns to paralyzed limbs, simply because the difficulty was always nothing more than a functional nervous disorder, which can be set aside by a nervous impression more powerful and profound than that which first produced the symptoms.

Temperament and Idiosyncrasy.—Temperaments may be defined to be peculiarities which characterize classes of individuals, whilst idiosyncrasies are peculiarities which belong to separate individuals. The word "temperament" is sometimes used by writers as synonymous with "diathesis," and yet the ideas expressed by the two terms are essentially different. Temperaments are natural conditions of the body which cannot be separated from any conception of the human race. Diathesis is defined by Billings to be "a state or condition of the body which predisposes to certain forms of disease." It is, in other words, a morbid tendency, a bodily peculiarity, which has been acquired by the individual himself or by the stock from which he has sprung, and which does not form a portion of an abstract conception of humanity.

The most usually accepted classification of temperament is into the nervous, the sanguine, the bilious, and the phlegmatic: but Dr. Thomas Laycock, who has written quite extensively on the subject, makes six divisions, which may be epitomized as follows:

1. Predominant innervation, or nervous temperament;
2. Predominant sanguinification, or sanguine temperament;
3. Predominant carbon excretion, or bilious temperament, associated with muscular activity and good innervation;
4. Tendency to fat-formation or deposit, with good muscular activity and low innervation and sanguinification; phlegmatic temperament.
5. Comparatively deficient innervation, sanguinification, muscular and vascular activity; lymphatic temperament;
6. Comparatively defective innervation, sanguinification, and vascular activity, with tendency to carbon deposit; melancholic temperament.

The American race is being formed by the fusion of individual elements of different origin, and it is rare to find an individual who closely approximates any typical definitions of the temperament. I do not think that in this country the question of temperament enters largely into the treatment of disease, unless it be in so far that there is a tendency to an excessive development of nervous sensitiveness, which is apt to be accompanied by excessive susceptibility to the action of remedies. In such individuals success is often obtained only by the use of doses which in phlegmatic subjects would produce no effect whatever.

The most important diatheses are the strumous and the gouty. When present they greatly modify the manifestations of acute and chronic diseases, and require careful and special treatment; but a discussion of this subject does not belong to a general introduction, and requires careful treatment in a separate chapter.

The physician who is desirous of success in his profession must always remember that he is treating not so much a disease as an individual, and that it is essential carefully to consult the peculiar tendencies, moral, mental, and physical, of the man or woman who is the patient. Some of these individual peculiarities occur so frequently that they may, to some extent, be foreseen. Thus, it will be found that in a large proportion of nervous, delicate, excitable women opiates produce violent nausea and after-depression, failing to act happily. For the greater part, however, idiosyncrasies are the peculiar properties of the individual, and cannot be known, even to the person most interested, except as the result of experience. They are often entirely unaccountable and beyond conception in their strangeness. Thus, a very active and renowned physician in Philadelphia is so susceptible to the odor of the hyacinth-plant that a single sprig of the flower in the room will produce in him nausea, followed by vomiting and collapse. A near relative of the writer was so susceptible to butter that the smallest portion of it, even cutting the bread with a knife that had been used to cut butter, would produce syncope. A physician, now dead, formerly a resident in the Pennsylvania Hospital, found that whenever he went on duty in the hospital he would become in a few days covered with boils, and so ill that he would be forced to go to bed. After this had been repeated a number of times it was discovered that it happened only when he was on duty in the surgical ward, but not until after he had resigned from the hospital was it made out that the attacks were due to the effects on his skin of the vapors of the turpentine used at that time to clean the marks of sticking-plaster off of the patients. Again, I have known of cases in which a few grains of ipecacuanha diffused through the air would produce violent bronchial irritation. Every student of asthma is aware that there are persons in whom asthmatic attacks are precipitated by some presence, otherwise intangible, that hangs about the air of certain rooms. I have seen a few grains of quinine repeatedly produce complete blindness in the same individual, and in other cases cause severe skin irritation. Another idiosyncrasy under my personal notice is that a few mouthfuls of lobster, boiled or broiled, will invariably produce an extraordinary and furious attack of herpes. These peculiarities are sometimes hereditary, as I know of a family in which eating an egg has in successive generations habitually caused in a few minutes violent headache, accompanied with fever, and after a short time an eruption upon the surface of the body.

Much space might be occupied with a description of the physical vagaries of humanity in their relations to drugs and to foods. The old saw, "One man's meat is another man's poison," expresses the whole matter. On the other hand, every physician is familiar with the fact that nothing is more common than for persons to imagine that they cannot take this or that remedy without the production of disagreeable and dangerous effects. Whilst, therefore, it is the duty of the doctor always, when called to a patient whose peculiarities are to him unknown, to inquire carefully for idiosyncrasies, care must be exercised in the proper weighing and appreciation of the statements made. I think that physicians more frequently err in refusing credence than in accepting too much.

Disease.—No circumstances affect the influence of medicine more than the morbid states of the individual that is being treated. For the purpose of discussion these morbid states can, at present, best be considered as follows: first, those for the remedying of which the remedy is given; second, those which are not being treated, but which at the same time may influence the action of the drug used.

It is evident that a direct antagonism often exists, if not between the medicine and the disease itself, at least between the drug and the cause of the disorder. A case of poisoning as the simplest example may be taken. We are so accustomed to considering poisonings as apart from disease that the illustration may not at first appear apt, but, after all, most acute disorders are nothing more or less than poisonings. There is no innate difference between an attack which is brought on by a mineral, vegetable, or animal poison that we call a drug because we use it in small dose for medical purposes, and an attack which is produced by a poison which we call a "natural cause" simply because we have not isolated the poison and employed it as the embodiment of a force capable, when properly used, of relieving human suffering. It is evident that if the system be under the influence of a drug A, which has produced a great depression of functional activity, a much larger amount of the drug B, which increases functional activity, must be used to produce a visible effect than would be required if the system were in normal condition. If a platform held up by a spiral spring be loaded with heavy weights, much greater force will be required to elevate it than would be otherwise required.

These remarks apply not only to the remedial, but to the physiological, action of drugs. In the man under the depressing influence of snake-poison, or of typhoid-fever poison, or of the ptomaïnes and other products which have been produced in his own system by the diphtheritic coccus,—in such a man doses of alcohol that in health would cause drunkenness produce no acceleration of the pulse, no mental confusion, no disorder of locomotion, and, what is most strange and almost unac-

countable, apparently are not eliminated. The power of the system under these circumstances of destroying the alcohol seems to be greatly increased beyond its normal limit, so that no odor appears on the breath, though the patient may be taking a pint of whiskey every twenty-four hours.

The resisting influence of one poison to that of another is felt both ways; the heart, that is stimulated by large doses of digitalis, responds less rapidly to the influence of aconite, precisely as one which is under the influence of aconite requires, in order for any appreciable effect to be produced, much more than the normal dose of digitalis. The mutual reaction of counteracting forces is easily understood, and would seem *a priori* to be a necessity inside of the human system as well as outside of it. It is not, however, so easily comprehended why conditions of body or of organs influence as much as they do the effects of remedies. It is, however, a thoroughly established clinical fact that the states of the body and of the tissues markedly affect the size of the doses which it is proper to use. In many cases of disease it is very difficult to decide how far the altered relations of medicine may be due to the direct counteracting influences of a poison, and how much to the conditions of the bodily forces. The cases of disease in which we have remedies that may be considered specific in character belong to this category. It is well established that malaria protects the general system from the action of quinine; twenty grains of the alkaloid will profoundly affect most normal individuals, whilst in malarial affections thirty, forty, and even fifty grains may be given without causing evidences of their physiological action. This may be due to the condition of the nervous system produced by malaria, but I think most physicians would be inclined to suppose that it is the result of the quinine being resisted by the malarial poison itself or by some of its products in the human body.

On the other hand, the syphilitic person withstands doses of mercury or of iodides that ordinarily cannot be given. This, I think, would generally be considered to be due, not to the presence in the body of any primary or secondary poison, but to the altered nutritive state of the tissues. That bodily conditions do affect the drug relations of the human organism is certain. In pure and simple exhaustion, whether it has been produced by disease, by over-exertion, or by long-continued depressing influences, or whether it is secondary to the over-use of a stimulant, much larger amounts of stimulants are required to make an impression than in health. In delirium tremens, in insomnia from excessive brain excitement, doses of narcotics which in health would almost paralyze fail to produce sleep. The heart that is weakened by structural changes responds but slowly to the largest doses of digitalis; the kidney that is fatty or atrophied is sluggish in all its reactions; the stomach whose mucous membrane is inflamed and whose blood-vessels

are dilated by habitual alcoholic excess scarcely perceives the irritating influences of the largest doses of capsicum.

From considerations such as these certain practical deductions naturally result. In most cases of general disorder the drug-forces may work in a manner that is antagonistic to the influence of the poison that is already present, or to the condition that is already present in the system. Usually, the indication is for the employment of those drug-forces which are antagonistic to the poison or condition. Remedies of this character are usually well borne, as it is technically expressed—*i. e.* they may be given and may do good in doses which are much larger than those of the textbooks. At the same time, it must never be forgotten that a fatal effect may be produced by over-dosing in these cases without the most prominent of the symptoms of the disorder being overcome. Especially is this true because most drugs have more than one action. As an example, take delirium tremens; if the practitioner insists at all hazards upon enforcing sleep by opium, he may do the patient fatal injury; in a case of tetanus convulsions can always be suspended summarily by the use of anæsthetics, chloral, and similar drugs, but the suspension of the convulsion may be accomplished at the cost of the patient's life. Sometimes, moreover, the drug which has failed to produce any symptoms of its action for a long time seems suddenly to overcome the antagonistic force and at once to act upon the system.

A curious and almost inexplicable illustration of the fact that a remedy may be acting when apparently it is exerting no influence sometimes occurs in the use of mustard plasters in conditions of excessive irritation. Thus, I have repeatedly known a person suffering from some violent internal irritation, with excessive pain, to allow a strong mustard plaster to stay on the skin perhaps for several hours without there being produced at the time any smarting, redness, or appreciable effect on the surface, although on the following day there was developed violent inflammation, with vesication or even sloughing of the skin, confined exactly to the site of the mustard plaster, proving that a very active effect had been produced by the plaster, although such effect was at first completely masked by the internal irritation. The mustard plaster counter-irritates against an internal irritation, but the internal irritation also counter-irritates against the mustard plaster. What takes place upon the surface of the body, openly and visibly to our senses, may also occur internally in a hidden manner. The utmost caution should therefore be practised in using drugs against internal poisons or diseases in such doses as would, in a healthy individual, actually endanger life; only under peculiar circumstances are these doses justifiable.

Diseases which affect the influence of drugs not used against them

are commonly local affections, which are of importance solely as offering some objection to employment of the otherwise indicated drugs. My experience has been that these side issues, so to speak, are frequently lost sight of by practising physicians, with great resulting injury to the patients, so that I think that it is not a waste of space to make detailed mention of some of the more frequent of them. Irritability and inflammation of the mucous membranes of the stomach and bowels contraindicate tonics, since simple bitters, quinine, nux vomica, and most preparations of iron are more or less irritating. Very many cases of general debility depend upon chronic irritation of the stomach or intestines. A little habitual diarrhœa, which consists simply of one loose passage a day, is apt to be overlooked, and the resulting debility is improperly treated with quinine and iron and similar remedies.

Of all ordinary remedies quinine is the one most frequently contraindicated by local disease at a time when it is indicated by the general condition. It is powerfully irritant to the gastro-intestinal tract: it congests or increases an already existing congestion of the middle ear, and is undoubtedly, when used too freely, capable itself of causing middle-ear deafness. It should never be given when there is a tendency to such disorder unless actually necessary for the saving of life.

The irritating influence of drugs is felt not only at their point of entrance, but also at their point of exit; hence, most irritants are contraindicated by the existence of irritation or tendency to irritation in the urinary organs. Quinine, when given freely, very greatly irritates the mucous membrane of the bladder, and for this reason in old persons who are prone to bladder irritability it must always be used with caution. Not long since I was paying a visit to a well-known surgeon, who was recovering from an attack of prostatic abscess under the care of an equally renowned surgeon. Convalescence was absolutely in abeyance, owing to a violent pain in the neck of the bladder which came on every afternoon. On inquiry I found that quinine was being given freely as a tonic, and when I told my surgical friends that I believed it was the cause of the pain, there was a good deal of astonishment; nevertheless, when the quinine was stopped the pain rapidly subsided.

The unreliability of empirical therapeutics, as well as the credulity of physicians in regard to absurd assertions, is seen in the enormous use which has been made of chlorate of potassium in diphtheria. The administration of the chlorate seems to have been based on the theory that it would yield nascent oxygen in the system and purify the blood. Chlorate of potassium is decomposed, however, only at a white heat. When ingested it is eliminated, unchanged, as the chlorate, and there is not the slightest reason for supposing that it is decomposed in the human system or that it has any influence in

diphtheria, save only as it exerts a slight local influence upon diseased mucous membranes. On the other hand, one of the chief dangers of diphtheria is nephritis, and chlorate of potassium is a violent irritant to the kidneys; yet it has been given almost universally in enormous doses in diphtheria. I have no doubt that a notable percentage of the deaths set down to diphtheria have been due in fact to the chlorate of potassium.

On the Combining of Drugs.

In prescribing medicines the physician ought always to bear in mind that the forces which he employs are capable of acting for evil as well as for good, and that in consequence drugs are not to be administered without good reason for their use. Such a principle as this is directly opposed to the habit of polypharmacy—*i. e.* to the custom of combining a large number of drugs into one avalanche of unknown and unknowable power. When a dozen active and perhaps more or less antagonistic agencies are thrown together into one confused mass, who can tell what will be the resultant angle of forces? If simplicity be not an unerring sign of the master in medicine, multiplicity of combination is without doubt the mark of the bungler and of the ignoramus. It is usually better to prescribe powerful remedies singly, but when circumstances seem to demand a combination of remedies such combination should only be made in accordance with definite rules or principles.

A very important consideration in regard to the combining of drugs, one which is not rarely lost sight of, is that even when drugs are to be exhibited together it is frequently better to keep them separate and uncombined, because the exigencies of the case may well require variations of the dose of the one without corresponding increase or decrease of the dose of the other. This is especially true when one medicine is comparatively inert and the other very active, or when it is desired to push one or more of the remedies to the full physiological limit. Even such learned and practical men as the framers of the U. S. Pharmacopœia have lost sight of this principle in various cases. According to my thinking, it is hard to conceive of a greater pharmaceutical abomination than the officinal citrate of iron and strychnine, which is made upon the principle of hitching together an ox and a race-horse. The iron preparations are of slow action, and in most cases it makes very little difference whether more or less than the average dose of them is given. Strychnine is a powerful and rapid remedy, whose dose should always be carefully graduated to the individual case of disease. The officinal preparation has no advantages whatever, and has the great disadvantage of leading the doctor to prescribe in a routine way without attempting to adapt doses to the needs of the indi-

vidual patient. Even such preparations as the iodide of iron are somewhat open to this objection. Very few physicians have any idea how much iodine the patient is getting when he is taking twenty drops of the syrup of the iodide of iron; and if the two remedies are to be given to the child, in my opinion it is generally better to give iron as iron and iodine as iodine.

The most important and practical of the rules governing the combining of remedies are as follows: First, *medicines are combined together to meet several coexisting indications.* The purpose expressed in this law is the one which most frequently leads to the use of the multiplicity of drugs, so that the practitioner should always remember the importance of not being led away by minor pointings of nature. An illustration of the application of the present law is in a prescription for a cough mixture in the first stages of a bronchial inflammation. In an ordinary case the indications would be to bring about secretion; hence the following prescription, in which two substances, the citrate of potassium and the syrup of ipecacuanha, are used to fulfil the indications, whilst the syrup and the lemon-juice are added to make the mixture less nauseous to the stomach:

℞. Potassii citratis, ℥j;
Succi limonis, f℥iss;
Syr. ipecacuanhæ, f℥ss;
Syrupi, q. s. ad f℥iij.

S. Dessertspoonful every two hours.

Supposing, however, there should be in any case an excessive nervous cough, morphine or some other narcotic might advantageously be added to the foregoing prescription, or if there were considerable arterial excitement the indication would be for the addition of tartar emetic or a similar remedy.

Second, *substances are combined for purposes of joint action or to modify the influence one of the other.* The application of this law is best illustrated by a purgative combination. Supposing a substance, A, acts upon the mucous membrane of the large intestine, while substance B influences especially the smaller intestine, and substance C affects the muscular coat. It is evident that when a thorough purgative action is desired the combination of all these three will act better than either remedy alone. It is for this reason that such polypharmaceutical preparations as the compound cathartic pill especially prevail among purgative remedies. Then, again, it has been found that certain narcotic substances lessen the irritation produced by the cathartic; hence narcotics are often put into purgative combinations to modify the action of the purgatives. Laudanum is habitually exhibited with castor oil, and the extract of belladonna added to the purgative pill.

Third, a very important law of combination is that which I venture to call *the law of crossed action.* Suppose, for instance, that a certain remedy, A, influences the system in such a way that its action can be represented by a horizontal line which runs through the point X, whilst the action of B is properly represented by a vertical line which also passes through the point X. It is evident that the point X will receive an impression proportionately much stronger than that of any other point of the body. A practical illustration of the value of this law is found in the great utility as a hypnotic of a mixture of chloral and morphine. Chloral acts upon the cerebral cortex as a somnifacient, and at the same time affects the heart and the spinal cord. Morphine acts upon the cerebral cortex as a somnifacient, but has little or no influence upon the spinal cord or the heart, although it is prone to disarrange digestion. A mixture of chloral and morphine, therefore, whilst powerfully acting upon the cerebral cortex as a hypnotic, influences the heart and spinal cord much less forcibly than would a corresponding dose of chloral, and disarranges digestion much less severely than would the corresponding dose of opium.

In the process of combining drugs the physician practises the art of prescription-writing, but as Professor Remington is to discuss this art in detail, my remarks upon it shall be restricted to a few considerations which might readily be everlooked by one who looks at the subject solely from a pharmaceutical point of view.

Almost every prescription consists of two parts—the vehicle and the remedy or remedies. In the case of mixtures or solutions it is usual for the physician to state what vehicle shall be employed. When a solid preparation is to be made, however, the choice of the excipient should be left to the apothecary, who will be much more apt than the physician to know the exact physical and chemical qualities required, as well as the necessary quantities.

Almost as great a reproach to the doctor as polypharmaceutical prescriptions is the habit of changing medicine unnecessarily and of prescribing it in too large quantities. Time is usually required for any effect to be produced by remedies, and a great array of unused bottles is, to many sick persons and their friends, a great aggravation. Care should be taken to adapt the number of doses in a prescription to the probable length of time during which it shall be used; not to prescribe fifty pills or a pint of mixture when ten pills or a few ounces are all that will be required.

Most medicines are nauseous. Among certain semi-barbarous tribes and peoples, including Irishmen and Irishwomen of the peasant class, the disagreeableness of a drug is intimately associated with the expectation of relief; but in this present age of over-comfort and luxury the physician who hopes to be successful amongst the better classes of society

will carefully study the art of rendering medicine as little unpleasant as possible. In doing this certain general rules of practice may be followed out. A remedy should not be given in a liquid form when it can as well be administered in solid. When the solid form is chosen it should be one that is readily soluble in the stomach, and at the same time insoluble in the mouth, as far as may be. The pill is better than the powder, but the gelatin capsule is better than the pill, because it is tasteless and at the same time rapidly disappears in the stomach. Sugar-coated pills were in their time an admirable product of the pharmaceutical art; at present they are inferior. Gelatin-coated pills are more readily soluble and as readily taken. A favorite preparation with many practitioners is the compressed pill, and when properly made of a substance fitted for this method of exhibition it is very commendable, on account of the smallness of its size in proportion to the dose which it contains. On the other hand, as it is often put upon the market composed of entirely insoluble substances, it may be a delusion and a snare. The basis of it should always be soluble. A compressed pill of quinine should be made of the bisulphate, and not of the sulphate. A compressed pill of a substance insoluble as sulphonal should never be made at all. The popularity of the compressed pill of sulphonal I think is one reason why this drug has so frequently failed in practical medicine. Probably any one who will watch the passages from the bowels of a patient taking these pills will find the pills, as I have done, discharged from the anus almost as fresh and bright as when taken into the mouth. If, instead of being made into a solid mass, the powder of suphonal, quinine, or other insoluble remedy be pressed not too tightly into a capsule, the best method of administration is obtained. Volatile oils and similar liquids, whose dose is small, are usually, when disagreeable in taste, best given in the capsules; especially is the so-called "soft" capsule adapted for the exhibition of liquids. Most persons can readily swallow a soft capsule containing one or two drachms. The use of the pill or capsule with very irritating substances requires some caution, lest the concentrated irritant should come in contact with the mucous membrane of the stomach. Usually this difficulty can be well met by administering the drug only when the stomach is full or by taking liquid with the dose.

PRESCRIPTION-WRITING AND THE COMBINATION OF DRUGS.

By JOSEPH P. REMINGTON, Ph. M.

Prescriptions.

The prescription [1] is the written direction of a physician indicating the remedy for a disease. All prescriptions may be classified under the two divisions—"official," or permanent, and "magistral," or extemporaneous.

"Official" prescriptions include all formulæ that are issued under official authority, as, for example, those of the various pharmacopœias, which are official in the various countries where the several pharmacopœias are issued. In the United States, however, those only are considered official that are contained in the "United States Pharmacopœia," which is issued by the authority of the Pharmacopœial Convention, a body convened especially for the purpose; or semi-official if by the "National Formulary," which is published under the authority of the American Pharmaceutical Association. Prescriptions for official formulæ can nearly always be dispensed by the pharmacist without delay, as official prescriptions are made in advance and are kept on his shelves ready for use.

"Magistral" prescriptions include such as are made up extemporaneously by the pharmacist according to special directions, and embrace those ordinarily prescribed by the physician: these are "unofficial," and might properly be called officinal, but this term has been used so long in the United States as meaning official that its use in this connection would no doubt lead to confusion.

A further great division of these two classes separates them into such as are used internally and such as are used for external application, and these are again subdivided into "Liquids" and "Solids," which are still further separated into groups or classes based upon similarity of composition or mode of preparation.

In writing prescriptions there are so many points to be considered that it requires rare knowledge and judgment to avoid falling into some mistake or inaccuracy, and prescriptions that can be considered as models in all respects are not frequently met with. They should always be written in a clear, legible hand on clean white paper, and with pen

[1] *Præscriptio—præ*, "before," and *scribo*, "I write."

and ink; if written with lead-pencil (which many physicians are in the habit of using), the characters are very apt to become blurred and indistinct before reaching the pharmacist.

Latin names should be used to designate the ingredients of the prescription, as being more definite and precise than English names. Latin being a dead language, its rules are fixed and established, and not liable to changes of fashion or fancy, as are living languages. It has been chosen as the language of science in all countries, and is the great storehouse from which the scientific world has ever been accustomed to draw its technical phraseology. The chief merit of Latin is its precision, and in no science is precision more important or necessary than in medicine. The Latin name applied to a drug is specific and has but one meaning, while in English the same name is often applied to many drugs; as, for example, "Indian hemp" is applied to Cannabis Indica, to Asclepias incarnata, and also to Apocynum cannabinum, drugs having entirely different properties. "Hellebore" is applied to Helleborus Americana, to Helleborus niger, to Veratrum album, to Veratrum viride, and to Dracontium fœtidum. "Snake-root" is applied to Aristolochia serpentaria, to Asarum Canadense, to Cimicifuga racemosa, to Eryngium aquaticum, to Eupatorium aromaticum, to Liatris spicata, to Macrotis, to Polygala senega.

On the other hand, many names are frequently applied to one drug; thus, "Gaultheria procumbens" is called checker-berry, box-berry, deer-berry, grouse-berry, spice-berry, tea-berry, partridge-berry, berried tea, gaultheria, trailing gaultheria, ground ivy, spicy wintergreen, and mountain tea.

It is frequently desirable that the patient should not be advised of the name of the medicine prescribed, and this object may generally be attained by the use of Latin.

When an unusually large dose of medicine is prescribed, it should be marked in some special way to show that such a dose is not a mistake, but is intended; this may be done by a note at the bottom of the prescription: "Correct dose" or "Intentional;" or by writing out the specific quantities in letters as well as in symbols or figures; thus, "ʒj (one drachm), gr. xxv (twenty-five grains);" an unusual dose is sometimes emphasized by underscoring or by an exclamation-mark, thus (!). When such precaution is not used a careful pharmacist may refuse to put up the prescription before consulting the physician, and thus valuable time may be lost.

Abbreviations of names are allowable only where there can be no doubt of their meaning, and such as may possibly admit of more than one meaning should be studiously avoided. The name of each ingredient and the quantity or amount of it required should always be placed on the same line.

Prescriptions should never be written partly in Latin and partly in English; such writing is evidence of either carelessness or ignorance. It is customary with some physicians to commence their prescriptions by writing down the names of the medicines which they intend to give, and afterward putting in the quantity desired of each article; objections to this plan are the liability or danger of transposing the quantities, or from oversight omitting to put down the quantity of one or more of the ingredients.

The physician should always sign his name to a prescription: the use of printed forms or prescription-blanks is very common, and very useful as giving the name, residence, and office-hours of the prescriber. If such forms are not used, it becomes still more important and desirable that the physician should sign his name to the prescription, so that in case of doubt or difficulty, either on account of the illegibility or any actual or supposed mistake, the pharmacist could communicate with the physician without the necessity of going to the patient and without the knowledge of the latter.

The name of the person for whom the prescription is intended should be written upon it, especially where there are two or more patients in the same house; as also the date when written. These precautions will frequently prevent mistakes which might otherwise occur; the date makes it convenient for reference, and may become of great importance from a medico-legal point of view.

Although there is no inflexible rule by which the order of the ingredients in a prescription may be determined, yet by following certain directions their best arrangement may be secured. A model prescription consists of some or all of the following parts:

1st. The superscription or heading;

2d. The inscription or enumeration of the ingredients, with their quantities;

3d. The subscription, or directions to the pharmacist;

4th. The signa, or direction for the patient as to the use of the medicine.

In addition to these parts should be added the name of the patient, the date when written, and the name of the physician, together with his address.

The superscription in Latin prescriptions consists of the letter ℞, the first letter of the word *Recipe* (take), being the imperative of the verb *recipio.* The most important part of the prescription is the inscription, the part requiring the knowledge and judgment of the physician in selecting the various remedies to be employed and apportioning their quantities. The principal active ingredient of a prescription is called the "basis;" this may be prescribed alone or in combination with other remedies. The next important ingredient in a mixture is the "vehicle," or, as sometimes called, the "diluent," which

furnishes the means of dividing and giving the proper dose of the medicine. If another medicine be added to assist the basis, it is called the "adjuvant," while articles intended to modify or qualify the action of the active ingredients are called "correctives."

The subscription is the direction to the pharmacist for compounding the prescription. Formerly it was the custom of the physician to give full directions for mixing the ingredients of a prescription and for compounding generally; these points are now usually left to the skill and judgment of the pharmacist, who is presumed to know how certain ingredients should be mixed, and short directions are generally given, such as misce (mix), solve (dissolve), fiat solutio, mistura, or pilula, as the case may be, leaving the mode of mixture and choice of excipient entirely to the pharmacist.

The signa, or direction intended for the patient, usually abbreviated "Sig.," or sometimes simply "S.," should always be written in English, distinctly and without abbreviation; written in Latin, it seems pedantic; besides which, there is liability to error in having the pharmacist translate it for the patient, who will certainly require it to be in English.

The following, illustrative of a modern model prescription, is given with a view of showing all of the parts:

Sept. 10, 1891.

For Mrs. E. M. T——.
Recipe (*Take*) } *Superscription.*

(*Basis.*) Extracti rhamni purshiani fluidi, fluidunciam;
Of fluid extract of cascara sagrada, 1 fluidounce;
(*Adjuvant.*) Extracti sennæ fluidi, semifluidunciam;
Of fluid extract of senna, ½ fluidounce;
Extracti glycyrrhizæ fluidi, fluidrachmas duas;
Of fluid extract of liquorice, 2 fluidrachms;
(*Corrective.*) Elixir aromatici, fluiduncias tres;
Of aromatic elixir, 3 fluidounces;
(*Vehicle.*) Syrupi, quantum sufficit ut fiant fluidunciæ sex;
Of syrup a sufficient quantity to make 6 fluidounces; } *Inscription.*

Misce, et filtra si opus sit.
Mix, and filter if necessary. } *Subscription.*

Signa (*mark or label*), *a dessert-spoonful at night.* } *Signa.*

George B. Wood.

ABBREVIATED FORM.

Sept. 10, 1891.

For Mrs. E. M. T——.
℞. *Ext. rham. pursh. fld.,* f℥j;
Ext. sennæ fld., f℥ss;
Ext. glycyrrh. fld., fʒij;
Elix. aromat., f℥iij;
Syrup. q. s. ft. f℥vj.
M. et filt. si op. sit.
Sig. A dessert-spoonful at night.

G. B. W.

Weights and Measures.—The ordinary weights and measures used in pharmacy and medicine are relics that have been bequeathed from a

past age, in which lack of system and uniformity are painfully apparent; they are as follows:

Apothecaries' Weight (also called Troy Weight).

Libra, Pound.		*Uncia,* Troy Ounce.		*Drachma,* Drachm.		*Scrupulus,* Scruple.		*Granum,* Grain.
℔ 1	=	12	=	96	=	288	=	5760
		℥ 1	=	8	=	24	=	480
				ʒ 1	=	3	=	60
						℈ 1	=	gr. 20

The British Pharmacopœia has adopted avoirdupois weight, which is also in general use in the United States for commercial purposes.

Avoirdupois Weight.

Pound.		Ounces.		Grains.
℔ 1	=	16	=	7000
		oz. 1	=	437.5

It will be observed that the troy ounce contains $42\frac{1}{2}$ grains *more* than the avoirdupois ounce, whilst the troy pound contains 1240 grains *less* than the avoirdupois pound. Fortunately, one unit common to troy, apothecaries', and avoirdupois weight has been saved—namely, *the grain.* The abbreviations of the denominations of apothecaries' weight are represented by the signs ℥, ounce; ʒ, drachm; ℈, scruple; and gr., grain: these have long been in use, but are very likely to be mistaken for one another in rapid or careless writing. The abbreviations or signs for avoirdupois weight differ from those of troy weight, and care should be used not to confound them; they are ℔., pound; oz., ounce; gr., grain.

MEASURES.

Apothecaries' or Wine Measure, U. S.

Congius, Gallon.		*Octarius,* Pint.		*Fluiduncia,* Fluidounce.		*Fluidrachma,* Fluidrachm.		*Minimum,* Minim.
Cong. 1	=	8	=	128	=	1024	=	61440
		O 1	=	16	=	128	=	7680
				f℥ 1	=	8	=	480
						fʒ 1	=	♏ 60

Imperial Measure, Br.

(Adopted by the British Pharmacopœia.)

Congius, Gallon.		*Octarius,* Pint.		*Fluiduncia,* Fluidounce.		*Fluidrachma,* Fluidrachm.		*Minimum,* Minim.
C. 1	=	8	=	160	=	1280	=	76800
		O 1	=	20	=	160	=	9600
				fl. oz. 1	=	8	=	480
						fl. dr. 1	=	min. 60

When the subject of the weights and measures in ordinary use is studied, the want of simplicity and close relation is clearly apparent. The pint of distilled water at 15.6° C. (60° F.) weighs 7291.2 grains, the fluidounce 455.7 grains, and we have thus three ounces in use of

different values: troy ounce, 480 grains; avoirdupois ounce, 437.5 grains; and fluidounce, 455.7 grains.

The Imperial measure differs from our wine measure principally in having twenty fluidounces in the pint instead of sixteen: a convenient relation exists, however, between measure and weight in the *Imperial gallon, which contains ten avoirdupois pounds of water at* 15.6° C. (60° F.).

The Imperial fluidounce contains the same number of grains as the avoirdupois ounce (437.5), which is 18.2 grains less than that of the U. S. fluidounce of water at the same temperature (455.7). Although this difference may be considered trifling in one fluidounce, it is not so when multiplied by four or eight; and this is one serious objection to the use of the English graduated measures in the United States, because they indicate Imperial fluidounces instead of U. S. fluidounces.

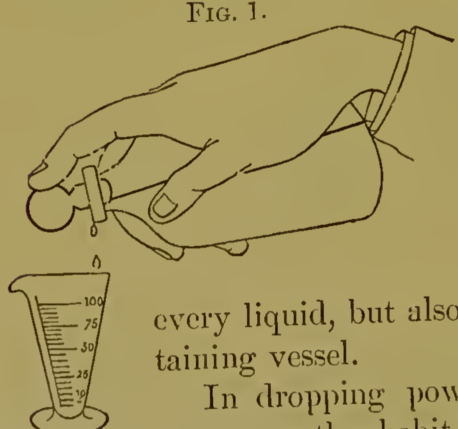
Much discussion has arisen respecting the comparative accuracy of preparing prescriptions by weighing or measuring. In the hands of a careful pharmacist either method will be found satisfactory, while with a careless one neither will be accurate. When, however, the difference in dosage, resulting from difference in size of spoons with which medicines are usually administered, is considered, the difference between the two methods will usually be insignificant. As liquid medicines are always given by measure, it would seem to be most rational to *prescribe liquids by measure,* and thus avoid the necessity for calculating the difference in dose due to the difference between weight and volume. In English-speaking countries the custom is firmly established of *weighing solids* and *measuring liquids.*

For convenience the following domestic measures are commonly used:

The tea-cup	(poculum)	equal to	f℥iv
wine-glass	(cyathus vinarius)	"	f℥ij
table-spoon	(cochlear magnum)	"	fʒiv
dessert-spoon	(cochlear medium)	"	fʒij
tea-spoon	(cochlear parvum)	"	fʒj.

All of the above measures vary very considerably in value, and therefore where accurate dosage is important the use of graduated glass measures or medicine-glasses, which can now be readily obtained, should be insisted on. The drop is usually considered to be equivalent to the minim; it is nearly so in the case of water, but varies not only with every liquid, but also with the size and shape of the containing vessel.

Fig. 1.



Dropping from Shop-bottle.

In dropping powerful liquids or when great care is necessary, the habit of holding the bottle as shown in Fig. 1 should be cultivated.

The Metric System in Prescriptions.—In view of the adoption of the metric system by the Pharmacopœia Convention of 1890, it is necessary that every pharmacist, and most desirable that every physician, should understand how to read and write prescriptions in this method. In order to avoid mistakes, a correct knowledge of the terms employed, together with a just appreciation of their values, is essential. The terms usually employed should be so thoroughly understood that when met with definite ideas of weight, capacity, or length, as the case may be, are immediately conveyed to the mind, without requiring a comparison with, or conversion into, ordinary or accustomed measures.

In Germany and some other continental countries prescriptions are prepared almost exclusively by weight, liquids as well as solids being thus dispensed, and quantities are all expressed in grammes. In this country, however, it is the custom to weigh solids and to measure liquids, with the exception of a few oily or viscid liquids, in which special cases weighing becomes more convenient than measuring.

The quantities employed in prescriptions are usually designated by multiples or subdivisions of the gramme for solids and of the cubic centimetre for liquids. Gm. is the abbreviation ordinarily used for the gramme, and c.c. that for the cubic centimetre, and they are always written after the quantities, thus differing from the ordinary method of writing prescriptions; moreover, the quantities are expressed in Arabic numerals, and not in Roman figures, again differing from the usual style.

The gramme is equivalent to about 15.5 grains (more exactly 15.432 grains), and the cubic centimetre is the measure of a gramme of distilled water; in order more thoroughly to show the relation existing between these, a cubic centimetre is sometimes called a fluigramme; this is equivalent to about 16 minims (more exactly 16.23 minims), and consequently 1 grain is equivalent to about 0.06 c.c. (6 hundredths of a cubic centimetre). The gramme is divided into 10 decigrammes, or 100 centigrammes, or 1000 milligrammes.

The term "decigramme" is rarely used, quantities being usually expressed in grammes and centigrammes; just as in our decimal currency we usually reckon by dollars and cents, seldom using dimes. Where fractions of a centigramme occur they are usually designated as so many milligrammes.

All the measures in this system are derived from the metre, hence it is called the Metric System; it is also called the Decimal System, because all the measures bear decimal relations to each other. The unit of length is the "metre," which is the forty-millionth part of the circumference of the earth around the poles: from this are derived all the other measures, including those of length, capacity, weight, and

area. The unit of capacity is the "litre," which is the measure of a portion of water that would just fill a hollow cube each side of which measures one-tenth of a metre. The unit of weight is the "gramme," which is the weight of a portion of water that would just fill a hollow cube each side of which measures one-hundredth of a metre; hence it is sometimes called a cubic centimetre (c.c.).

From these units the other measures are derived, and are designated by prefixes: those which indicate increase are derived from the Greek, while those which indicate decrease are derived from the Latin. The Greek prefixes are deka, 10; hecto, 100; kilo, 1000; and myria, 10,000. The Latin prefixes are deci, $\frac{1}{10}$; centi, $\frac{1}{100}$; and milli, $\frac{1}{1000}$; and these prefixes to the names of the units give the following tables:

	Metres.		Litres.		Grammes.
1 millimetre, mm. =	.001	1 millilitre, ml. =	.001	1 milligramme, mg. =	.001
1 centimetre, cm. =	.01	1 centilitre, cl. =	.01	1 centigramme, cg. =	.01
1 decimetre, dm. =	.1	1 decilitre, dl. =	.1	1 decigramme, dg. =	.1
1 metre, m. =	**1.**	**1 litre, l. =**	**1.**	**1 gramme, gm. =**	**1.**
1 dekametre, dm. =	10.	1 dekalitre, dl. =	10.	1 dekagramme, dg. =	10.
1 hectometre, hm. =	100	1 hectolitre, hl. =	100.	1 hectogramme, hg. =	100.
1 kilometre, km. =	1,000.	1 kilolitre, kl. =	1,000.	1 kilogramme, kg. =	1,000.
1 myriametre, mm. =	10,000.	1 myrialitre, ml. =	10,000.	1 myriagramme, mg. =	10,000.

It will be observed that the significant unit in all of the above tables is 1, and that the differences in value are distinguished by the position of the decimal point; hence it is all important that this point should be properly placed. In writing prescriptions the use of a line to distinguish between grammes or cubic centimetres and their fractions, similar to the line used for dividing dollars and cents in books of account, is safer and less liable to error than the use of the decimal point; it is also much more convenient than writing the denominations after each quantity, as is sometimes done. These methods are illustrated by the following prescriptions:

	Gm. & c.c.	
Tinct. ferri chlor.,	2	5
Acid. acet. dilut.,	3	75
Liq. ammon, acet.,	25	
Elixir aurantii,	12	5
Syrupi,	20	
Aquæ, q. s. ut ft.	60	

M. Ft. sec. art.

	Gm.
Tinct. ferri chlor.,	2.5
Acid. acet. dilut.,	3.75
Liq. ammon. acet.,	25.
Elixir aurantii,	12.5
Syrupi,	20
Aquæ, q. s. ut ft.	60

M. Ft. sec. art.

Tinct. ferri chlor.,	2.5 gm.
Acid. acet. dilut.,	3.75 gm.
Liq. ammon. acet.,	25 gm.
Elixir aurantii,	12.5 gm.
Syrupi,	20 gm.
Aquæ, q. s. ut ft.	60 gm.

M. Ft. sec. art.

	Gm. & c.c.	
Ext. coloc. comp.,	2	
Abst. jalapæ,	1	5
Hyd. chlor. mitis,	1	75
Pulv. gambogiæ,		4

Misce et div. in pil. No. xxv.

	Gm.
Ext. coloc. comp.,	2.
Abst. jalapæ,	1.5
Hyd. chlor. mitis,	1.75
Pulv. gambogiæ,	.4

Misce et div. in pil. No. xxv.

Ext. coloc. comp.,	2 gm.
Abst. jalapæ,	1.5 gm.
Hyd. chlor. mitis,	1.75 gm.
Pulv. gambogiæ,	.4 gm.

Misce et div. in pil. No. xxv.

	Gm. & c.c.	
Pulv. cretæ,	7	5
Pulv. acaciæ,	5	
Pulv. sacchari,	12	5
Aquæ cinnam.,	60	
Aquæ, q. s. ut ft.	cxx.	

	Gm.
Pulv. cretæ,	7.5
Pulv. acaciæ,	5
Pulv. sacchari,	12.5
Aquæ cinnam.,	60
Aquæ, q. s. ut ft.	cxx.

Pulv. cretæ,	7.5 gm.
Pulv. acaciæ,	5 gm.
Pulv. sacchari,	12.5 gm.
Aquæ cinnam.,	60 gm.
Aquæ, q. s. ut ft.	cxx. gm.

It will be observed that in the above prescriptions both the volumetric and gravimetric methods are used. In the gravimetric method liquids as well as solids are weighed, while in the volumetric method solids are weighed and liquids are measured; cubic centimetres (c.c.) being used in place of grammes.

Instead of learning rules for converting ordinary weights and measures into those of the metric system, it will probably be found more convenient and less difficult to memorize a few equivalent values, and from these to calculate other values.

The following equivalents will be found useful:

Lengths.

1 inch, about 25 mm. (25.3997 mm.).
1 foot, " 30 cm. (30.48006 cm.).
1 yard, " 91 cm. (91.44010 cm.).

Liquid Measures.

♏j = about 0.06 c.c. (.0616 c.c.).
fʒj = " 3.75 c.c. (3.6967 c.c.).
f℥j = " 30 c.c. (29.5739 c.c.).
Oj = " 500 c.c. (0.47318 L.).
Oij = " 1000 c.c. (0.94636 L.).

Weights.

gr. j	=	about	0.06 gm. (64.7989 mg.).
gr. xv	=	"	1 gm. (97.189 cg.).
ʒj	=	"	4 gm. (3.8879 gm.).
℥j	=	"	30 gm. (31.10348 gm.).

The equivalents of French measures are as follows:

Lengths.

1 millimetre,	mm.	=	about	$\frac{1}{24}$ inch.
1 centimetre,	cm.	=	"	$1\frac{5}{12}$ inches.
1 decimetre,	dm.	=	"	4 "
1 metre,	m.	=	"	$39\frac{3}{8}$ "

Liquid Measures.

1 millilitre, or cubic centimetre, c.c.	=	about	♏16.
1 centilitre, or 10 cubic centimetres	=	"	fʒ$2\frac{3}{4}$.
1 decilitre, or 100 cubic centimetres	=	"	f℥$3\frac{3}{8}$.
1 litre, or 1000 cubic centimetres	=	"	f℥34.

Weights.

1 milligramme,	mg.	=	about	$\frac{1}{64}$ grain.
1 centigramme,	cg.	=	"	$\frac{1}{6}$ "
1 decigramme,	dg.	=	"	$1\frac{1}{2}$ "
1 gramme,	gm.	=	"	$15\frac{1}{2}$ "

Inasmuch as many of the terms and titles used in medicine and pharmacy to-day were unknown to the ancients, new names based on Latin types have become a necessity: the following condensed glossary, however, will prove serviceable in presenting nearly all of the terms and phrases in common use that are likely to occur in prescriptions:

CONDENSED GLOSSARY.

Abdomen,	The belly,	Abd.
Absente febre,	Fever being absent,	Abs. feb.
Accurate,	Accurately,	Acc.
Ad,	To, or up to,	Ad.
Ad defectionem animi,	To fainting,	Ad def. an.
Ad duas vices,	At twice taking,	Ad 2 vic.
Ad gratam aciditatem,	To an agreeable sourness,	Ad. grat. acid.
Ad libitum,	At pleasure,	Ad lib.
Ad secundum vicem,	To the second time,	Ad sec. vic.
Ad tertiam vicem,	For the third time,	Ad 3 tiam vic.
Addantur,	Let (them) be added,	Add.
Adde,	Add,	Add.
Addendo,	By adding,	Add.
Addendus,	To be added,	Add.
Adhibendus,	To be administered,	Adhib.
Adjacens,	Adjacent,	Adjac.
Admove,	Apply,	Admov.

Admoveantur,	Let (them) be applied,	Admov.
Admoveatur,	Let (it) be applied,	Admov.
Adstante febre,	The fever being on,	Adst. feb.
Adversum,	Against,	Adv.
Aggrediente febre,	While the fever is coming on,	Aggred. feb.
Agitato vase,	The vial being shaken,	Agit. vas.
Aliquot,	Some,	Aliq.
Alter,	The other,	Alt.
Alternis horis,	Every other hour,	Alt. hor.
Aluta,	Leather,	Aluta.
Alvo adstrieta,	The bowels being eonfined,	Alv. adstr.
Alvus,	The belly,	Alv.
Amplus,	Large,	Amp.
Ampulla,	A large bottle,	Ampul.
Ana,	Of eaeh,	A. or āā.
Aqua,	Water,	Aq.
Aqua astricta,	Frozen water,	Aq. astr.
Aqua bulliens,	Boiling water,	Aq. bull.
Aqua eommunis,	Common water,	Aq. eom.
Aqua fervens,	Hot water,	Aq. ferv.
Aqua fluvialis or fluviatilis,	River water,	Aq. fluv.
Aqua fontalis,	Spring water,	Aq. font.
Aqua fontana or fontis,	Spring water,	Aq. font.
Aqua marina,	Sea water,	Aq. mar.
Aqua nivialis,	Snow water,	Aq. niv.
Aqua pluvialis or pluviatilis,	Rain water,	Aq. pluv.
Aquarius,	Pertaining to water,	Aquarius.
Aut,	Or,	Aut.
Balneum arenæ,	Sand-bath,	B. A.
Balneum mariae or maris,	Salt-water bath,	B. M.
Balneum vaporosum or vaporis,	Vapor-bath,	B. V.
Balsamum,	Balsam,	Bals.
Barbadensis,	Barbadoes,	B. B.
Bene,	Well,	Bene.
Bibe,	Drink (thou),	Bib.
Biduum,	Two days,	Bid.
Bis,	Twice,	Bis.
Bis in die or dies,	Twice a day,	Bis die.
Bolus,	A large pill,	Bol.
Bulliat or Bulliant,	Let boil,	Bull.
Bulliens,	Boiling,	Bull.
Butyrum,	Butter,	But.
Cæruleus,	Blue,	Cærul.
Calefactus,	Warmed,	Calef.
Calomel or Calomelas,	The mild chloride of mercury,	Cal.
Cape,	Take (thou),	Cap.
Capiat,	Let him take,	Cap.
Capsula,	A eapsule,	Capsul.
Caute,	Cautiously,	Caute.

Charta,	Paper,	Chart.
Chartula,	A small paper,	Chartul.
Cibus,	Food,	Cib.
Coehlear, or Cochleare,	A spoonful (ʒj),	Coch.
Cochleare amplum,	A dessert-spoonful (ʒij),	Coch. amp.
Coehleare infantum,	A ehild's spoonful,	Coch. inf.
Cochleare magnum,	A table-spoonful (℥ss),	Coch. mag.
Cochleare medium or modieum,	A dessert-spoonful (ʒij),	Coeh. med. or mod.
Coehleare parvum,	A tea-spoonful (ʒj),	Coeh. parv.
Coehleatim,	By spoonfuls,	Cochleat.
Coctio,	Boiling,	Coet.
Cola,	Strain,	Col.
Colaturæ,	To the strained liquor,	Colatur.
Colatus,	Strained,	Colat.
Coletur,	Let it be strained,	Colet.
Colentur,	Let them be strained,	Colent.
Collutorium,	A mouth-wash,	Collut.
Collyrium,	An eye-wash,	Collyr.
Coloretur,	Let it be colored,	Coloret.
Compositus,	Compound,	Comp.
Concisus,	Cut,	Coneis.
Confectio,	Confection,	Conf.
Congius,	A gallon,	Cong.
Conserva,	A eonserve, also Keep (thou),	Cons.
Continuantur remedia,	Let the medieines be eontinued,	Cont. rem.
Continueter,	Let it be eontinued,	Cont.
Contusus,	Bruised,	Contus.
Coque ad medietatis consumptionem,	Boil to the consumption of half,	Coq. ad Med. Consump.
Coque, Coquantur,	Boil, let them be boiled,	Coq.
Coque in suffieiente quantitate aquæ,	Boil in suffieient water,	Coq. in S. A.
Coque seeundum artem,	Boil aeeording to art,	Coq. S. A.
Cor, Cordis,	The heart,	Cor.
Cornu eervi,	Hartshorn,	C. C.
Cortex, Cortieis,	The bark,	Cort.
Coxa,	The hip,	Cox.
Cras,	To-morrow,	Cras.
Cras mane sumendus,	To be taken to-morrow morning,	Cras mane sumend.
Cras noete,	To-morrow night,	Cras nocte.
Cras vespere,	To-morrow evening,	Crasp vest.
Crastinus,	To-morrow,	Crast.
Cujus, Cujus-libet,	Of whieh, Of any,	Cuj.
Cum,	With,	C.
Cyatho theæ,	In a eup of tea,	Cyatho theæ.
Cyathus, or Cyathus vinarius,	A wine-glass (℥j–ij),	Cyath., C. vinar.
Da, detur,	Give, let it be given,	D., det.
De,	Of, or from,	De.
Deaurentur pilulæ,	Let the pills be gilded,	Deaur. pil.
Debita spissitudo,	A proper eonsistence,	Deb. spiss.

Debitus,	Due, proper,	Deb.
Decanta,	Pour off,	Dec.
Decem, Decimus,	Ten, the tenth,	Decem, Decim.
Decoctum,	A decoction,	Decoct.
Decubitus,	Lying down,	Decub.
De die in diem,	From day to day,	De d. in d.
Deglutiatur,	Let be swallowed,	Deglut.
Dein vel Deinde,	Thereupon,	Dein.
Dejectiones alvi,	Stools,	Dej. alv.
Detur in duplo,	Let twice as much be given,	Det. in dup.
Dexter, Dextra,	The right,	Dext.
Diebis tertiis,	Every third day,	Dieb. tert.
Diebus alternis,	Every other day,	Dieb. alt.
Digeratur,	Let it be digested,	Dig.
Diluculo,	At break of day,	Diluc.
Dilue, Dilutus,	Dilute (thou), Diluted,	Dil.
Dimidius,	One half,	Dim.
Directione propriâ,	With a proper direction,	D. P. or Direct prop.
Dividatur in partes æquales,	Let it be divided into equal parts,	D. in p. æq.
Dividendus, -a, -um,	To be divided,	Divid.
Dolor,	Pain,	Dolor.
Donec,	Until,	Donec.
Donec alvus bis dejeciatur,	Until the bowels have been twice evacuated,	Donec alv. bis. dejic.
Donec alvus soluta fuerit,	Until the bowels shall be opened,	Donec alv. sol. ft.
Donec dolor nephriticus exulaverit,	Until the nephritic pain is removed,	Donec dolor. neph. exulav.
Dosis,	A dose,	D.
Drachma,	A drachm (60 grains),	Dr. or ʒ.
Durante dolore,	While the pain lasts,	Dur. dolor.
Eadem (fem.),	The same,	Ead.
Eburneus,	Made of ivory,	Eburn.
Ejusdem,	Of the same,	Ejusd.
Electuarium,	An electuary,	Elect.
Emesis,	Vomiting,	Emesis.
Enema,	A clyster or enema,	En.
Enemata,	Clysters,	Enem.
Et,	And,	Et.
Evanuerit,	Shall have disappeared,	Evan.
Exhibeatur,	Let it be exhibited,	Exhib.
Extende,	Spread,	Ext.
Extende super alutam mollem,	Spread upon soft leather,	Ext. sup. alut. moll.
Extractum,	An extract,	Extr.
Fac,	Make,	F.
Fac cataplasmatem,	Make a poultice,	F. cataplasm.
Fac pilulas duodecim,	Make 12 pills,	F. pil. xij.
Farina,	Flour,	Farina.
Fasciculus,	A small bundle,	Fasc.
Febre durante,	During the fever,	Febr. dur.
Febris,	Fever,	Febr.

Femoribus internis,	To the inner thighs,	Fem. intern.
Fervens,	Boiling,	Ferv.
Fiant,	Let them be made,	Ft.
Fiant chartulæ xij,	Let 12 powders be made,	Ft. chart. xij.
Fiant pilulæ xij,	Let 12 pills be made,	Ft. pil. xij.
Fiant pulveres xij,	Let 12 powders be made,	Ft. pulv. xij.
Fiant suppositoria iv,	Let 4 suppositories be made,	Ft. suppos. iv.
Fiant trochisci xxiv,	Let 24 troches be made,	Ft. troch. xxiv.
Fiat,	Let it be made,	Ft.
Fiat ceratum,	Let a cerate be made,	Ft. cerat.
Fiat collyrium,	Let an eye-wash be made,	Ft. collyr.
Fiat emplastrum vesicatorium,	Let a blister be made,	Ft. emp. vesic.
Fiat emulsio,	Let an emulsion be made,	Ft. emuls.
Fiat enema,	Let an enema (an injection for the rectum) be made,	Ft. enem.
Fiat injectio,	Let an injection (for the urethra) be made,	Ft. inject.
Fiat lege artis,	Let it be made by the rules of art,	F. L. A.
Fiat massa, et divide in pilulas xij,	Let a mass be made, and divide it into 12 pills,	Ft. mas. div. in pil. xij.
Fiat pulvis,	Let a powder be made,	Ft. pulv.
Fiat pulvis in chartulas xij dividenda,	Let a powder be made to be divided into xij little papers,	Ft. pulv. in chart. xij, div.
Fiat solutio,	Let a solution be made,	Ft. sol.
Fiat unguentum,	Let an ointment be made,	Ft. ung.
Fiat venesectio,	Let a bleeding be done,	Ft. venesec.
Fictilis,	Earthen,	Fict.
Filtra,	Filter (thou),	Filtra.
Filtrum,	A filter,	Filt.
Fistula armata,	A syringe ready for use,	Fistul. arm.
Flores,	Flowers,	Fl.
Fluidus,	Liquid,	Fluid., Fl.
Formula,	A prescription,	Form.
Frustillatim,	In small pieces,	Frust.
Fuerit,	Shall have been,	Fuerit.
Gargarisma,	A gargle,	Garg.
Gelatina quavis,	In any kind of jelly,	Gelat. quav.
Gradatim,	By degrees, gradually,	Grad.
Gramme,	Gram,	Gm.
Grana sex pondere,	Six grains by weight,	Gran. vj, pond.
Granum, Grana,	Grains, Grains,	Gr.
Gratus,	Pleasant,	Grat.
Gummi guttæ gambiæ,	Gamboge,	G. G. G.
Gutta, Guttæ,	A drop, Drops,	Gtt.
Guttatim,	By drops,	Guttat.
Guttis quibusdam,	With a few drops,	Gtt. quibusd.
Harum pilularum summantur tres,	Let three of these pills be taken,	Har. pil. sum. iij.
Haustus,	A draught,	Haust.
Haustus purgans noster,	A purgative draught after my own (formula),	H. p. n.

Hebdomada,	A week,	Hebdom.
Herba,	An herb,	Herb.
Herbarum recentium,	Of fresh herbs,	Herb. recent.
Heri,	Yesterday,	Heri.
Hic, Haec, Hoc,	This,	Hic, Haec, Hoc.
Hirudo,	A leech,	Hirudo.
Hora,	An hour,	H.
Horâ decubitus,	At bedtime,	Hor. decub.
Horâ somni,	At the hour of sleep,	Hor. som.
Horâ undecimâ matutinâ,	At the eleventh hour of the morning,	Hor. xj, matut.
Horæ unius spatio,	For the space of one hour,	Hor. j, spat.
Horis intermediis,	In the intermediate hours,	Hor. intermed.
Idem,	The same,	Id.
Idoneus,	Proper,	Idon.
Imprimis,	First,	Impr.
Incide, Incisus,	Cut (thou), Being cut,	Inc.
Indies,	Daily, or From day to day,	Ind.
Infunde,	Pour in,	Infun.
Infusum,	An infusion,	Infus.
Injectio,	An injection,	Injec.
Injiciatur enema,	Let a clyster be given,	Injic. enem.
In pulmento,	In gruel,	In pulm.
Instar,	Like,	Instar.
Inter,	Between,	Inter.
Internus, -a,- um,	Inner, or Internal,	Int.
Intus,	Inwardly,	Intus.
Jam,	Now,	Jam.
Julepus, Julepum, Julapium,	A julep,	Jul.
Jusculum,	A broth,	Jusc.
Juxta,	Near to,	Juxta.
Kali præparatum,	Prepared potash, or the Carbonate of potassium,	Kal. ppt.
Lac, Lactis,	Milk, of Milk,	Lac.
Lagena,	A flask or bottle,	Lag.
Lana,	Flannel, Wool,	Lana.
Languor,	Faintness,	Lang.
Lateri dolenti,	To the painful side,	Lat. dol.
Lectus,	A bed,	Lect.
Libra,	A pound,	Lb. or ℔.
Libræ,	Pounds,	Lib. or Llb.
Linimentum,	A liniment,	Linim.
Linteum,	Lint,	Lint.
Liquor,	A solution,	Liq.
Lotio,	A lotion,	Lot.
Macera,	Macerate,	Mac.
Magnus,	Large,	Mag.
Mane,	In the morning,	Mane.
Mane primo,	In the very early morning,	Mane primo.
Manipulus,	A handful,	M. or Man.
Manus,	The hand,	Manus.
Massa,	A mass or pill-mass,	Mass.
Matutinus,	In the morning,	Matut.

Medius,	Middle,	Med.
Mensura,	By measure,	Mensur.
Mica panis,	Crumb of bread,	Mic. pan.
Minimum,	A minim,	♏ or Min.
Minutum,	A minute,	Minut.
Misce,	Mix,	M.
Mistura,	A mixture,	Mist.
Mittatur,	Let (it) be sent,	Mit.
Mittantur,	Let (them) be sent,	Mit.
Mitte,	Send,	Mit.
Mitte sanguinem ad uncias duodecim saltem,	Take away blood to 12 ounces, at least,	Mit. sang. ad uncias xij, salt.
Modicus,	Middle-sized,	Modic.
Modo præscripto,	In the manner prescribed,	Mod. præsc.
Mora,	Delay,	Mora.
More dictu,	In the manner directed,	Mor. dict.
More solito,	In the usual manner,	Mor. sol.
Morturarium,	A mortar,	Mort.
Nec-non,	Also,	Necn.
Ne trades sine nummo,	Do not deliver without the money,	Ne. tr. s. num.
Nisi,	Unless,	Nisi.
Nocte maneque,	At night and in the morning,	Noct. maneq.
Non,	Not,	Non.
Non repetatur,	Let it not be repeated,	Non repetat.
Nox, Noctis,	The night, of the Night,	Nox, Noct.
Nucha,	The nape of the neck,	Nucha.
Numero,	In number,	No.
Numerus,	Number,	No.
Nux moschata,	A nutmeg,	Nux mosch.
Octarius,	A pint (℥xvj),	O., Oct.
Octavus,	Eighth,	Octav.
Octo,	Eight,	Octo.
Oleum lini sine igne,	Cold-drawn linseed oil,	Ol. lini sine ig.
Oleum olivæ optimum,	Best olive oil,	Ol. O. opt.
Omni biduo,	Every two days,	Omn. bid.
Omni bihorio,	Every two hours,	Omn. bih.
Omni horâ,	Every hour,	Omn. hor.
Omni mane,	Every morning,	Omn. mane.
Omni nocte,	Every night,	Omn. noct.
Omni quadrante horæ,	Every quarter hour,	Omn. quadr. hor.
Opus,	Need or occasion,	Opus.
Ovum,	An egg,	Ov.
Pannus,	A rag,	Pan.
Pars, Partis,	A part, of a Part,	Par., Pt.
Partes æquales,	Equal parts,	Pt. æq.
Partitis vicibus,	In divided doses,	Part. vic.
Parvulus,	An infant, A parvule,	Parvul.
Parvus,	Little,	Parv.
Pastillus, Pastillum,	A pastille,	Pastil.
Pediluvium,	A foot-bath,	Pediluv.

Penicillum camelinum,	A camel's-hair pencil or brush,	Penic. cam.
Per,	Through, By,	Per.
Per deliquium,	By deliquescence,	Per deliq.
Per fistulam vitream,	Through a glass tube,	Per fist. vit.
Peracta operatio emetici,	When the action of the emetic is finished,	Peract.operat.emet.
Pergo, Pergere,	To go on with,	Perg.
Phiala,	A vial or bottle,	Phi.
Phiala prius agitata,	The bottle having been first shaken,	P. P. A.
Pilula,	A pill,	Pil.
Pocillum,	A little cup,	Pocill.
Poculum,	A cup,	Pocul.
Pondere,	By weight,	P.
Pondus civile,	Civil weight (avoirdupois),'	P. civ.
Pondus medicinale,	Medicinal weight,	P. med.
Pone aurem,	Behind the ear,	Pone aur.
Post singulas sedes liquidas,	After every loose stool,	Post sing. sed. liq.
Potus,	Drink,	Potus.
Præparata,	Prepared,	Præp.
Primo mane,	Very early in the morning,	Primo mane.
Primus,	The first,	Primus.
Pro,	For,	Pro.
Pro ratione ætatis,	According to the age of the patient,	Pro rat. æt.
Pro re nata,	Occasionally, According to circumstances,	P. r. n.
Pugillus,	A pinch,	Pug.
Pulmentum,	Gruel,	Pulm.
Pulverizatus,	Powdered,	Pulvz.
Pulvis,	A powder,	Pulv.
Pulvis patrum,	Jesuits' bark,	P. P.
Pyxis,	A pill-box,	Pyxis.
Quadrans, Quadrantis,	A quart,	Quad.
Quantum libet,	As much as you please,	Q. lib.
Quantum placet,	" " " "	Q. p.
Quantum satis,	As much as is sufficient,	Q. s.
Quantum sufficiat,	" " " "	Q. s.
Quantum vis,	As much as you please,	Q. v.
Quantum volueris,	" " " "	Q. vol.
Quâquâ horâ,	Every hour,	Qq. hor.
Quaque,	Each, or Every,	Qq.
Quartus,	Fourth,	Quart.
Quater,	Four times,	Quater.
Quatuor,	Four,	Quat.
Quibus,	From which,	Quibus.
Quinque,	Five,	Quinq.
Quintus,	The fifth,	Quint.
Quoque,	Also,	Q. q.
Quorum,	Of which,	Quor.
Quotidie,	Daily,	Quotid.
Rasuræ,	Shavings,	Ras.

Ratio,	Proportion,	Ratio.
Recens, Recentis,	Fresh,	Rec.
Recipe,	Take,	℞.
Rectificatus,	Rectified,	Rect.
Redactus in pulverem,	Reduced to powder,	Red. in pulv.
Redigatur in pulverem,	Let it be reduced to powder,	Redig. in pulv.
Regio umbilici,	The umbilical region,	Reg. umbil.
Reliquus,	Remaining,	Reliq.
Repetantur,	Let them be repeated,	Rept.
Repetatur,	Let it be repeated,	Rept.
Respondere,	To answer,	Respond.
Retinere,	To keep,	Retin.
Saltem,	At least,	Saltem.
Saturatus, -a, -um,	Saturated,	Sat.
Scatula,	A box,	Scat.
Scilicet,	Namely,	Scil.
Scrupulum,	A scruple (20 grains),	Scrup. or ℈.
Secundum artem,	According to art,	S. A.
Secundum naturam,	According to nature,	S. N.
Secundus,	Second,	Secund.
Sedes,	The alvine evacuation,	Sed.
Semel,	Once,	Semel.
Semi-drachma,	Half a drachm,	Semidr.
Semi-hora,	Half an hour,	Semih.
Semis, or Semissis,	A half,	Ss.
Septem,	Seven,	Sept.
Septimana,	A week,	Septim.
Sescuncia,	An ounce and a half,	Sescunc.
Sesquihora,	An hour and a half,	Sesquih.
Sex,	Six,	Sex.
Sextus,	Sixth,	Sext.
Si,	If,	Si.
Si non valeat,	If it does not answer,	Si non val.
Si opus sit,	If necessary,	Si op. sit.
Si vires permittant,	If the strength will bear it,	Sir. vir. perm.
Signa,	Write, or Mark (thou),	Sig.
Signatur nomine proprio,	Let it be written upon with its proper name,	Sig. nom. prop.
Simul,	Together,	Simul.
Sine,	Without,	Sin.
Singularum,	Of each,	Sing.
Singulorum,	Of each,	Sing.
Sit,	Let it be,	Sit.
Solus,	Alone,	Sol.
Solutus,	Dissolved,	Solut.
Solve,	Dissolve,	Solv.
Solvo, Solvere,	I dissolve, To dissolve,	Solv.
Somnus,	Sleep,	Somnus.
Spiritus, -ûs,	Spirit,	Spt.
Spiritus vini rectificatus,	Rectified spirit of wine (*i. e.* alcohol),	Spt. vin. rect.
Spiritus vini tenuis,	Proof spirit,	Spt. vin. ten.

Spiritus vinosus,	Ardent spirit (of any strength),	Spt. vinos.
Statim,	Immediately,	Stat.
Stet, or Stent,	Let it (or them) stand,	St.
Stratum superstratum,	Layer upon layer,	S. S. S.
Sub finem coctionis,	When the boiling is nearly finished,	Sub. fin. coct.
Subactus,	Subdued,	Subact.
Subinde,	Frequently,	Subind.
Sumantur,	Let them be taken,	Sum.
Sumat,	Let him take,	Sum.
Sumat talem,	Let him take one like this,	Sum. tal.
Sumatur,	Let it be taken,	Sum.
Sume,	Take,	Sume.
Sumendus,	To be taken,	Sum.
Summitates,	The summits,	Summit.
Superbibendo haustum,	Drinking afterward this draught,	Sup. bib. haust.
Supra,	Above,	Supra.
Syrupus, Syrupi,	Syrup,	Syr.
Tabella,	A lozenge,	Tab.
Talis,	Such a one,	Tal.
Tempori dextro,	To the right temple,	Tempor. dext.
Tempus, Temporis,	Time, or Temple,	Temp.
Ter,	Thrice, or Three times,	Ter.
Ter in die, or Ter die,	Thrice daily,	T. i. d., or T. d.
Tere,	Rub,	Tere.
Tere simul,	Rub together,	Tere. sim.
Tero,	I rub,	Tero.
Tertius,	Third,	Tert.
Tinctura,	Tincture,	Tinct. or Tr.
Tincturæ Herbarum Recentium,	Tinctures of fresh herbs,	Tinct. Herb. Recent.
Tres,	Three,	Tres.
Triduum,	Three days,	Trid.
Tritura,	Triturate,	Trit.
Trochiscus, Trochisci,	A lozenge or troche, Lozenges or troches,	Troch.
Tussis,	A cough,	Tus.
Ultimo (or Ultima) præscriptus,	The last ordered,	Ult. præsc.
Una,	Together,	Una.
Uncia,	An ounce,	Unc. or ℥.
Usque ad deliquium,	To fainting,	Usq. ad deliq.
Ut dictum,	As directed,	Ut dict.
Utendum,	To be used,	Utend.
Uto, Uti,	I use, To use,	Uto, Uti.
Vas vitreum,	A glass vessel,	Vas vit.
Vehiculum,	A vehicle or menstruum,	Vehic.
Vel,	Or,	Vel.
Venæsectio brachii,	Bleeding in the arm,	Venæsec. brach.
Vesper, Vesperis,	The evening,	Vesp.
Vices,	Turns,	Vic.

Vinum,	Wine,	Vin.
Vires,	Strength,	Vir.
Vitello ovi Solutus,	Dissolved in the yolk of an egg,	Vitel. ovi Sol.
Vitellus,	Yolk,	Vitel.
Vitellus ovi,	Yolk of an egg,	Vitel. ovi.
Vitreum, Vitrum,	Glass,	Vitr.
Vomitione urgente,	Vomiting being severe,	Vom. urg.

The arrangement of the various elasses of preparations used in preseriptions has an important bearing in presenting to the mind of the reader a eonsistent sequence, and it is believed that the classification used by the author in his work *The Practice of Pharmacy* (1891, 2d ed.), and shown separately on page 274 of that work, is also well adapted for use in this SYSTEM OF THERAPEUTICS. Of eourse the seope of the present artiele precludes the possibility of entering into sueh minute observations as would only be of interest to a pharmacist, but in the eonsideration of the various preparations which follow suffieient information must be given of pharmaeeutical operations to eonvey to those who are unskilled in the mysteries of the ancient art a fair eoneeption of the proeesses whieh furnish the preparations; this much being assumed, however, that all who use this work have previously had some knowledge of pharmaey, the tendeney of all modern medieal edueation being to reeognize that advanees in therapeutics go hand in hand with progress in pharmaey and the elevation of both professions.

The elassification referred to above first divides all offieial preparations into two classes—*liquids* and *solids*. Liquids are arranged aeeording to the relative solubility of the substanee in the solvent seleeted, the charaeter of the solvent aiding also in the classifieation; simple solvents, as water, syrup, alcohol, glyeerin, etc., holding the first rank. The proeess of pereolation whieh is now universally used in Ameriea divides pharmaeeutical preparations very naturally into classes, and as it involves only *partial solution* (the larger portion of inert matter in drugs, the ligneous fibre, being rejeeted), preparations in whieh *solution is complete* or nearly so should have the first place, beeause the principles involved are simpler and more direet. With these views as a guide, the first preparations to eonsider are the official aqueous solutions (waters and solutions and aqueous solutions eontaining sweet or viseid substances), then in suecession liquid preparations made by solution with aleohol, ether, oils, and oleic acid as solvents; the seeond sub-class introduces the preparations made by percolation or maceration, and here the same order is observed: first, those made with water as a menstruum and water eontaining acid (infusions and deeoctions and vinegars); then aleoholic pereolates (tinctures, wines, and

fluid extracts), followed by ethereal preparations and the oleoresins. This completes the first division, and the solids are now considered, the first of this class being those made by the evaporation or precipitation of the percolates of the first class, and thus the sequence is maintained. The last sub-class is composed of solids made without percolation or maceration, and under this head are grouped all of the solid preparations usually made extemporaneously.

Liquids.

Aqueous Solutions.

Aquæ (Waters).—Waters, or medicated waters of the Pharmacopœia, are aqueous solutions of volatile substances, and are almost exclusively used as solvents or pleasant vehicles for the administration of various medicines. They are prepared in several different ways:

Firstly, by simple solution, agitating the volatile liquid with water until dissolved, and if necessary filtering the solution. Bitter-almond-water and creasote-water are thus prepared.

In the case of solutions of gases, the gases, after being generated in suitable apparatus, are passed through water until solutions of the proper strength are obtained.

Water of ammonia, stronger water of ammonia, and chlorine-water are prepared in this manner.

Secondly, by percolating water through oil which has previously been thoroughly distributed on cotton and firmly packed in a suitable percolator. The following waters are thus prepared: viz. anise-water, camphor-water, cinnamon-water, fennel-water, peppermint-water, and spearmint-water.

This process was substituted in the Pharmacopœia of 1880 for that formerly official, which consisted in thoroughly mixing the oil with carbonate of magnesium and water, and then filtering the solution through paper: the object of using the carbonate of magnesium was to divide the oil thoroughly, and thus expose a greater surface to the action of the water, by which means it became completely saturated.

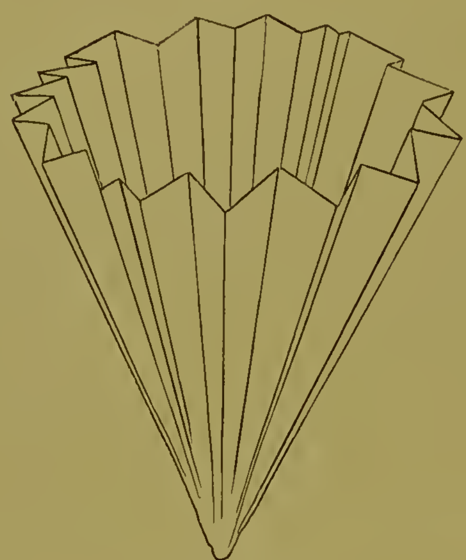
Notwithstanding the change made by the Pharmacopœia—which perhaps was not an improvement—it is feared that the great majority of pharmacists throughout the country do not follow the official directions, but adhere to the old method of using the carbonate of magnesium. The use of carbonate of magnesium was objected to on account of its slight solubility, which unfitted the water thus made for preparing certain solutions, as, for example, solution of nitrate of silver, where a slight decomposition would take place; for making such solutions, however, distilled water should at all times be used.

Instead of using carbonate of magnesium to diffuse the volatile oil,

many other substances have been proposed and used, such as magnesia, precipitated phosphate of calcium, porcelain clay, powdered silica, finely-powdered glass, powdered pumice-stone, powdered talcum or soapstone, etc.: none of these substances, however, are superior to carbonate of magnesium.

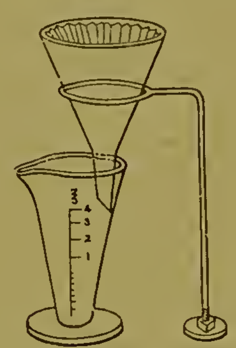
The process of filtration, so frequently performed by the pharmacist, is effected by folding bibulous paper, made especially for the purpose and termed filtering-paper, into a conical shape, as seen in Fig. 2, and then placing the filter in a funnel, moistening or washing the filter by pouring water through it, and then pouring into the filter the liquid which is to be made transparent. The clear liquid flowing from the filter is termed the *filtrate*.

Fig. 2.



Plaited Filter.

Fig. 3.



Arrangement of Funnel in Filtration.

Fig. 3 shows a good method of supporting a funnel and filter during filtration, the end of the funnel touching the side of the graduate to prevent splashing.

Another unofficial method of making medicated waters which has been tried and recommended is that of using hot water in making the solutions. This method is founded on the fact that most of the volatile oils are much more soluble in hot than in cold water. By this plan the volatile oil is agitated with hot water in a metallic vessel or bottle until the water becomes saturated, and after standing until the oil separates, the water is separated from the excess of oil and filtered.

In prescribing, saturated solutions of salts should not be made with the medicated waters, for the reason that the waters being themselves saturated solutions, the various volatile substances from which they are prepared, not being so soluble in saturated solutions as they are in water, are precipitated, thus disturbing the transparency of the solution.

Take, for example, the following prescription:

℞.
Potassii bromidi, ʒvj;
Aquæ camphoræ, q. s. ut ft. f℥ij.
M. ft.

From this solution a portion of the camphor is precipitated, thus making an inelegant and unsightly preparation. The careful pharmacist, having prepared such a solution, would probably filter it; this would remove the precipitated camphor, but the quantity thus removed would not be enough to make any appreciable difference either in the taste or in the dose. This difficulty may be avoided by using equal parts of water and camphor-water to make the solution.

The following prescriptions show the use of medicated waters as vehicles and solvents:

℞.
Sodii bicarb., ʒij;
Spt. ammon. arom., fʒss;
Syrupi, f℥j;
Aq. menth. virid., f℥iij;
M. Ft. in solutio.
Sig. Soda mint. A table-spoonful 3 times a day.
T. U. T.

℞.
Potassii iodidi, ʒijss;
Syr. aurantii, fʒiij;
Aq. cinnamom., f℥iij.
M. Ft. in solutio.
Sig. A tea-spoonful 4 times a day.
T.

℞.
Antipyrin., ʒj;
Syrupi, f℥ss;
Aq. carui, ad f℥ij.
M. Ft. in solutio.
Sig. One tea-spoonful every hour, as directed.
W.

℞.
Sodii salicylat., ʒj;
Syrupi, f℥j;
Aquæ menth. pip., ad f℥iij.
M. Ft. in solutio.
Sig. Two tea-spoonfuls every 3 hours.
M. L. V.

Liquores (Solutions).—"Liquores" of the Pharmacopœia are aqueous solutions of substances entirely soluble in the solvent selected, exclusive of those coming under the definitions of Waters and Syrups. To this definition there is one exception—"the solution of gutta-percha," the solvent of which is not water, but chloroform. All of the others may be separated into two classes—those which are simply solutions in water, and those in which chemical action is involved in the solution. Most of them possess active medicinal properties, and some of them are poisons. There are twenty-six official solutions: four of them contain arsenic—namely, solution of arsenious acid, solution of arsenite of potassium, solution of arseniate of sodium, and solution of iodide of arsenic and mercury; the arsenical strength of each of these is 1 per cent. Six of the "liquores" are used only externally: these are solu-

tion of gutta-percha, solution of nitrate of mercury, solution of subacetate of lead, diluted solution of subacetate of lead, solution of chloride of zinc, and solution of silicate of sodium. The names of the other official solutions are as follows: solutions of acetate of ammonium, lime, acetate of iron, chloride of iron, citrate of iron, citrate of iron and quinine, nitrate of iron, subsulphate of iron, tersulphate of iron, citrate of magnesium, pepsin, potassa, citrate of potassium, soda, chlorinated soda, and compound solution of iodine.

℞.
Hydrarg. iodid. rub., gr. xviij;
Potassii iodidi, gr. xiv;
Aq. destill., f℥iv.
Ft. solutio.
Sig. Channing's solution. Take five drops in water 3 times a day. W. V. K.

℞.
Morphinæ sulph., gr. j;
Aq. destill., f℥j.
M. Ft. in solutio.
Sig. A tea-spoonful at night. L. A. S.

Aqueous Solutions containing Sweet or Viscid Substances.

Syrupi (Syrups).—Syrups are concentrated solutions of sugar in aqueous fluids; they are valuable preparations, being permanent when well made, their sweet taste rendering them acceptable to the palate and making them useful vehicles for the administration of many medicines.

A solution of sugar in water, of the proper strength, is called "syrupus" or syrup; other syrups take their names from the medicinal or flavoring substances from which they are prepared, and are known as medicated or flavoring syrups.

Medicated syrups are prepared from various liquids, such as infusions, decoctions, vinegars, solutions, etc., and are made in several different ways, depending in each case upon the physical condition, chemical composition, and other peculiarities of the substances employed.

Flavoring syrups are not medicinal in their action, but are used for flavoring drinks of various kinds, and are useful in disguising the taste of unpleasant medicines. They are prepared from fruits, and also from a variety of aromatic or pleasantly flavored substances.

There are thirty-four syrups official in the Pharmacopœia; in five of them the solution of sugar is effected by heat; these are "syrup," syrup of lime, syrup of raspberry, syrup of bromide of iron, and syrup of iodide of iron.

In eighteen syrups the sugar is dissolved in the medicated liquids by agitation without heat; these are the syrups of garlic, ginger, hydriodic acid, hypophosphites, lactophosphate of calcium, lemon, orange, orange-flowers, the phosphates of iron, quinine, and strychnine,

rhubarb, senna, squill, tar, wild-cherry, compound syrup of sarsaparilla, and compound syrup of squill.

Ten of the syrups are prepared by mixing the medicating substances with the syrup; they are as follows: aromatic syrup of rhubarb, syrups of acacia, citric acid, hypophosphites with iron, ipecac, krameria, lactucarium, rose, rubus, and senega. One syrup (the syrup of tolu) is made by digestion. Syrups should not be prescribed with strong alcohol, for the sugar may be thrown out of solution and precipitated, or it may crystallize out on standing.

Herewith are presented a few prescriptions illustrating the use of syrups:

℞.
Acid. phosph. dil., f℥iv;
Syr. aurant. flor., f℥iss.
Ft. solutio.
Sig. Two tea-spoonfuls in water 3 times a day. N. L.

℞.
Quinin. sulph., ℨss;
Aq. ammon., gtt. iij;
Syr. glycyrrhizæ, f℥ij.
Fiat mistura.
Sig. Shake the bottle and take a tea-spoonful twice a day. T. R.

℞.
Sodii brom., ℥ss;
Chloral. hydrat., ℨiiss;
Syr. aurantii flor., f℥ss;
Aquæ, q. s. ft. f℥ij.
Ft. solutio.
Sig. A dessert-spoonful at night in water.

℞.
Tinct. ferri chlor.,
Acid. phosph. dil., *āā.* f℥j;
Syr. limon., f℥iv.
Ft. solutio.
Sig. A dessert-spoonful in water after meals. I. F. G.

℞.
Hydrarg. chlor. cor., gr. j;
Liq. arsen. chlor., fℨj;
Tinct. ferri chlor.,
Acid. hydrochl. dil., *āā.* fℨiv;
Syr. zingiber., f℥iij;
Aquæ, q. s. ft. f℥vj.
Ft. solutio.
Sig. A dessert-spoonful in water after meals. A. H. S.

℞.
Antipyrin., ℨj;
Syr. tolut., f℥ij.
Ft. solutio.
Sig. A dessert-spoonful in water every 2 hours until relieved. V.

Mellita (Honeys).—Honey is a secretion deposited by the well-known honey-bee. It has no special medicinal value, but its pleasant taste and demulcent properties render it a pleasant vehicle for mixtures and gargles, and useful as an excipient, for which purposes, after hav-

ing been clarified, it is used in the official preparations containing it—honey of rose, confection of rose, and the mass of carbonate of iron.

℞.

Pulv. alumin.,	gr. xx ;
Mel. rosæ,	f℥j.
Ft. solutio.	

Sig. Apply to the sore mouth as directed. M. T.

℞.

Sodii bor.,	gr. xx ;
Mel. despum.,	f℥j.
Ft. solutio.	

Sig. Use as directed. N. L.

Mucilagines (Mucilages).—Mucilages are solutions in water of the gummy or mucilaginous principles of vegetable substances. They are not permanent preparations, and should not be prepared in large quantities. In pharmacy, mucilages are used as demulcents either internally or externally, as eye-washes, as excipients, and as vehicles for the administration of various remedies. There are five mucilages official, those of acacia, cydonium, and sassafras-pith being made with cold water, while those of elm and tragacanth are made with boiling water. The mucilages of acacia and of tragacanth, if not to be used for medicinal purposes, may be rendered more permanent by the addition of a small portion of creasote or volatile oil.

℞.

Ol. terebinth.,	ʒj ;
Pulv. sacch. alb.,	gr. xxx ;
Muc. acaciæ,	f℥ss ;
Aquæ, q. s. ft.	f℥iv.
Ft. mistura.	

Sig. A tea-spoonful 3 times a day.

℞.

Copaibæ,	f℥ss ;
Liq. potassæ,	fʒij ;
Spt. æth. nit.,	fʒj ;
Tinct. opii,	fʒij ;
Muc. acaciæ,	fʒiv.
Ft. mistura.	

Sig. A tea-spoonful 3 times a day. F. F. M.

Misturæ (Mixtures).—Mixtures are aqueous preparations in which insoluble materials are mechanically suspended. Under this heading the Pharmacopœia includes mixtures containing oleaginous matters, which, being distinctive, should be separated from mixtures and classified under the title "Emulsions." The term "mixture" is frequently applied, but pharmaceutically incorrectly so, to perfect solutions where two or more ingredients are mixed together. The special purpose of mixtures is to disguise the taste of unpleasant remedies or to facilitate their admininistration, the vehicle used being generally of a syrupy or mucilaginous character, whereby the insoluble substances are held in suspension. Mixtures are mostly extemporaneous preparations, and cannot be kept long; they should therefore be made in only such quantities as are immediately wanted.

The official mixtures are as follows: chalk, compound iron, com-

pound mixture of glycyrrhiza, magnesia, and asafetida, acetate of iron and ammonium, almond, ammoniac, asafetida, chloroform, citrate of potassium, and rhubarb and soda. Of these the mixture of acetate of iron and ammonium is improperly named; it, being a perfect solution, should be classed among the "Liquores," while, as we have said before, the following mixtures should be named emulsions: viz. almond, ammoniac, asafetida, and chloroform. This last-named substance, not being oily in its character, is nevertheless made into an emulsion by means of the yolk of egg. Emulsions are prepared by making a thick mucilage of acacia with water, and then very slowly and gradually introducing the oily substance to be emulsified, stirring constantly with a light motion, without using pressure (see Fig. 4), the object being to entangle the globules of oil and envelop each one with a thin layer of mucilage; these enveloped globules float in the water, and then resemble closely the type of all emulsions, cow's milk or cream.

FIG. 4.

Emulsion Mortar and Pestle.

The following are illustrations of methods of prescribing mixtures:

℞.

Res. guaiaci,		gr. xlv;
Pulv. acaciæ,		
Pulv. sacch. alb.,	*āā.*	gr. xl;
Aq. cinnamomi,		f℥iv.
Ft. mistura.		

Sig. A tea-spoonful 3 times a day.
N. G. W.

℞.

Ol. picis liq.,	fʒj;
Chloroform.,	♏xx;
Ol. menth. pip.,	♏v;
Pulv. ext. glycyrrh.,	ʒij;
Pulv. sacch. alb.,	℥j;
Alcoholis,	f℥ss;
Acaciæ,	q. s.
Aquæ, q. s. ft.	f℥iv.
M. Ft. mistura.	

Sig. A tea-spoonful 3 times a day.
W. K. T.

Glycerita (Glycerites).—Glycerites are mixtures or solutions of medicinal substances made with glycerin. Only two are official—the glycerite of starch, which is made by first mixing thoroughly starch and glycerin, and afterward heating the mixture until the starch-granules are completely dissolved; and the glycerite of yolk of egg, which is made by rubbing the two ingredients together until thoroughly

mixed. Possessing demulcent and emollient properties, both of them are used as protective local applications to irritated surfaces, while the glycerite of yolk of egg has been recommended as a basis for emulsionizing cod-liver and other oils.

Formerly glycerites of borax and tannic acid were official; both of these were useful and valuable preparations, and even now are perhaps more used than are the official glycerites.

Formulas for both of them are given in the National Formulary:

℞.
Boroglycerid., fʒij;
Glycerini, fʒvj.
Ft. solutio.
Sig. Apply as directed. V. T.

℞.
Acidi tannici, ʒj;
Glycerini, f℥ss.
Ft. solutio.
Sig. Use as directed. M. L.

℞.
Ol. morrhuæ, f℥j;
Spt. frumenti, f℥ss;
Glycerit. vitelli, f℥iss;
Ft. emulsio.
Sig. A table-spoonful after meals.
W. N. H.

℞.
Ext. belladon., gr. xij;
Ext. opii, gr. vj;
Glycerit. amyli, ℥ss.
Ft. unguentum.
Sig. Use as directed.
E. W.

Alcoholic Solutions.

Spiritus (Spirits).—"Spirits" of the Pharmacopœia are alcoholic or hydro-alcoholic solutions of volatile substances, and are prepared either by solution or distillation.

The principal use of the aromatic spirits is to give agreeable taste and flavor to medicines of various kinds or to correct their nauseating or griping tendencies.

Spirits should not be prescribed with aqueous mixtures without carefully considering the relative quantities of each, or the oily substance will be apt to be thrown out of combination; the addition of gum or other emulsionizing substance is then proper to prevent separation at the time of administering.

Nearly all of the official spirits are made by solution, only one (the spirit of nitrous ether) being made by chemical action and two (brandy and whiskey) by distillation. The other official spirits are as follows: spirits of ammonia, anise, camphor, chloroform, cinnamon, ether, gaultheria, juniper, lavender, lemon, myrcia, nutmeg, peppermint, and spearmint; aromatic spirit of ammonia, compound spirit of ether, compound spirit of juniper, and perfumed spirit. The following prescriptions illustrate various methods of administering spirits:

℞.
Potassi acet., ʒij;
Spt. junip. comp., fʒiv;
Spt. æth. nit., fʒj;
Infus. scoparii, f℥iv.
Ft. solutio.
Sig. Two table-spoonfuls thrice daily. W. H. D.

℞.
Chloroformi,
Spt. ammon. arom., āā. fʒiv;
Tinct. opii camph.,
Spt. ætheris comp., āā. f℥j;
Ovi vitelli, j.
Ft. mistura.
Sig. A tea-spoonful as required.
E. H.

℞.
Spt. chloroformi,
Tinct. card. comp., āā. f℥ij.
Sig. A tea-spoonful every half hour until relieved.
B.

℞.
Morph. sulph., gr. iss;
Ext. cannabis, gr. x;
Spt. ammon. arom., ♏ xx;
Spt. ætheris, f℥j;
Spt. gaultheriæ, f℥iss.
Ft. solutio.
Sig. Half a tea-spoonful at night.
W. W.

℞.
Spt. camphoræ, f℥j;
Lin. saponis, f℥iij;
Ft. linimentum.
Sig. Use as directed. L. E. A.

℞.
Bismuth. subnit., ʒj;
Cretæ præparatæ, ʒij;
Spt. menth. vir., fʒij;
Syrupi, fʒiv;
Aquæ, q. s. ft. f℥iv.
Ft. mistura.
Sig. A tea-spoonful every 4 hours.
M.

Elixiria (Elixirs).—Elixirs are liquid preparations containing sugar and alcohol, usually combined with aromatics, and generally not possessing much medicinal activity, their particular object being to disguise or render pleasant to the taste medicines otherwise disagreeable. Of late years they have been very extensively used, being pleasing to the eye as well as fragrant and palatable.

Only one elixir is official in the Pharmacopœia, although in the National Formulary no less than eighty-six formulas are given, many of which, though used in some parts of the country, contain substances which are totally unfitted to be made into elixirs. The official preparation is "elixir of orange," which is a very pleasant elixir, and is designed simply as a vehicle for other substances. Illustrations of the methods of prescribing elixirs are appended on the following page:

℞.
Lithii citratis, ʒij;
Elix. aurantii, f℥iij.
Ft. solutio.
Sig. A tea-spoonful 4 times a day.
N. W.

℞.
Antipyrin., ʒj;
Elix. aurantii, f℥j.
Ft. solutio.
Sig. A tea-spoonful every 2 hours, as directed.
B. N. W.

℞.
Potass. acet., ʒiiss:
Ext. junip. fld., fʒss;
Elix. aurantii, f℥iv;
Aquæ, q. s. ft. Oss.
Sig. A dessert-spoonful 3 times a day.
P. S. T.

℞.
Quininæ sulph., gr. xvj;
Cinchonidin. sulph.,
Cinchoninæ sulph., *āā*. gr. viij;
Elix. aurantii, Oj.
Ft. solutio.
Sig. A tea-spoonful 3 times a day.
M. M.

℞.
Potass. brom., fʒv;
Acid. citric., gr. viij;
Elix. aurantii, q. s. ft. f℥iv.
Ft. solutio.
Sig. A tea-spoonful as required.
O. R. L.

℞.
Ext. paulliniæ fld., f℥iss;
Ext. glycyrrhizæ fld., fʒss;
Elix. aurantii, fʒvj.
Ft. mistura.
Sig. A tea-spoonful every 3 hours.
W. S. R.

Ethereal Solutions.

Collodia (Collodions).—Collodions are liquid preparations used for external application. They are made by dissolving pyroxylin or gun-cotton in a mixture of ether and alcohol, and are variously medicated, being thus made the vehicles of several important medicines. When applied to the skin the ether and alcohol evaporate, leaving a thin film, which either acts as a protection to the surface below or brings a medicinal agent in contact with the part to which it is applied. The following collodions are official: Collodion, collodion with cantharides, flexible collodion, and styptic collodion. Ordinary collodion produces a film which is slightly contractile; flexible collodion contains a trace of castor oil and Canada turpentine: these being non-volatile, the film is rendered softer and somewhat elastic. Flexible collodion is used when a covering for the epidermis is needed which will allow of some motion of the part, as, for instance, upon an abraded knuckle. Several other forms of collodions have come into use for special purposes, as carbolized collodion and iodoform collodion.

Herewith are presented some of the modes of prescribing collodions:

℞.
Collod. c. canth., f℥ss.
Sig. Apply with a camel's-hair brush, as directed.
T. N.

℞.
Tinct. iodi.,
Spt. ammoniæ,
Collodii, *āā.* fʒij.
M.
Sig. Apply at night, as directed.
V. V.

℞.
Acid. carbolic., gtt. ij;
Collod. flexilis, f℥ss.
M.
Sig. Apply as directed.
L. A.

℞.
Iodoformi, gr. v;
Collod. flexilis, fʒij.
Ft. solutio.
Sig. Brush upon the part, as directed.
M. K.

Oleaginous Solutions.

Linimenta (Liniments).—Liniments are preparations to be applied to the skin, usually by friction, and are generally liquid or of such consistence as to become liquefied when applied. They are largely used and are valuable preparations, most of them being beneficial not only on account of their intrinsic merits, but because the friction usually employed in their application induces more or less counter-irritation.

The following official liniments may be used by inunction: ammonia, belladonna, camphor, chloroform, subacetate of lead, soap, and compound liniment of mustard.

Lime liniment and liniment of turpentine are used for burns, and are simply applied to the affected parts.

Liniments may be prescribed as follows:

℞.
Thymol., ʒss;
Ol. terebinth., f℥ij;
Ol. origani, fʒiv;
Ol. gossypii, f℥v.
Ft. linimentum.
Sig. Rub into the affected parts.
A. W. L.

℞.
Tinct. aconiti,
Chloroformi,
Aq. ammoniæ, *āā.* fʒij;
Linim. saponis, q. s. ft. f℥viij.
Ft. linimentum.
Sig. Use as directed, locally.
N. W.

℞.
Lin. aconiti,
Lin. belladonnæ, *āā.* fʒij;
Lin. saponis, q. s. ft. f℥ij.
Ft. linimentum.
Sig. Apply as directed.
C. E. M.

℞.
Ol. tereb., f℥iij;
Ovi vitelli, j;
Ol. limon., ♏.xxx;
Acid. acetic., fʒv;
Aq. rosæ, f℥iiss.
Ft. linimentum.
Sig. Apply as directed.
A. C. B.

Oleata (Oleates).—Oleates are preparations made by dissolving alkaloids or metallic oxides in oleic acid. Some are solid and some are liquid; the only two which are official, oleate of mercury and oleate of veratrine, are liquid, being solutions of the oleates in an excess of oleic acid. They have been recommended as being more readily absorbed when applied to the skin, and therefore quicker and more efficient in their action, than ordinary ointments prepared with other fatty bodies, while at the same time they are more cleanly in their application.

Some of the unofficial oleates are compounds containing oleic and stearic acids; these are usually in the form of fine powder.

The following prescriptions exhibit the use of oleates:

℞.
Zinci oleati,
Talci præparati, āā. ℥ss.
Misce et fiat pulv. subtil.
Sig. Dust upon the part night and morning. U.

℞.
Cupri oleati, ℥i;
Petrolati, ℥iij.
Ft. unguent.
Sig. Apply with caution night and morning. R. A. S.

℞.
Oleati veratrin., f℥ss.
Sig. Apply with a camel's-hair brush, as directed.
M. N.

℞.
Hydrargyri oleati (20 %), ℥ss;
Lanolini, ℥iiss.
Ft. unguent.
Sig. Apply 3 times daily.
V. W. R.

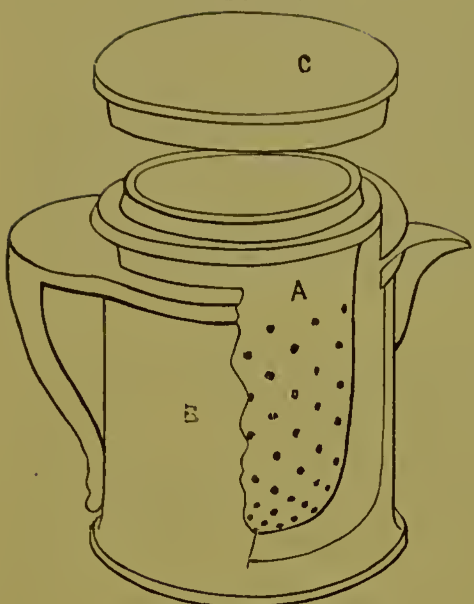
Aqueous Liquids made by Percolation or Maceration.

Infusa (Infusions).—Infusions are solutions of the soluble principles of drugs, either in cold or hot water, made without boiling. They are not permanent preparations, undergoing decomposition in a short time, and should not be prepared in larger quantities than the immediate occasion demands.

Infusions of drugs which contain either volatile principles or principles that are injured by heat should be made with cold water. Infusions can be made more quickly by the use of hot water, but in consequence of the solution of extractive and inert matters which are very slowly deposited when the infusions cool, preparations thus made are not clear, the precipitated particles being so minute that they cannot be separated by straining or filtration.

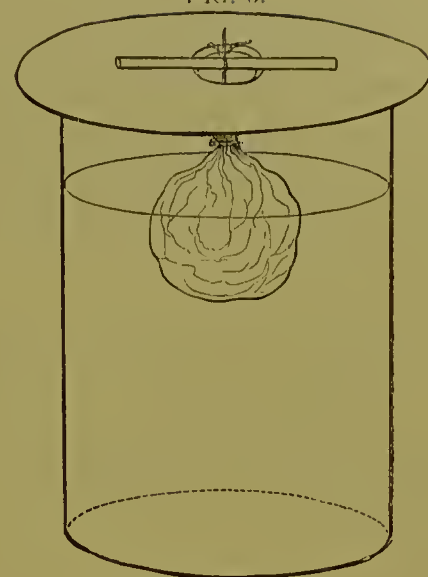
The official processes for infusions are maceration and percolation. By maceration is meant soaking a drug in a menstruum until it is softened and the soluble portion is dissolved. Fig. 5 shows Squire's infusion mug. The substance to be infused is deposited in the queensware colander A; this is placed then in the mug B; hot or cold water poured over it, the cover C put in position, and the whole allowed to stand for the required length of time. In Fig. 6 a simple method of

Fig. 5.



Squire's Infusion Mug.

Fig. 6.



Circulatory Solution.

making an infusion which obviates the necessity of straining is shown. The substance, properly comminuted, is tied in a piece of cheese-cloth or muslin, as shown, and then suspended at the top of the liquid. The liquid in contact becomes saturated, falls to the bottom, and fresh liquid takes its place, a circulatory solution being effected. In Fig. 7 an application of this principle for making hot infusions is shown. There are five official infusions, three of which are made by maceration in boiling water: these are infusion of digitalis and compound infusion of senna, both of which are directed, after maceration, to be strained; and infusion of brayera, which is directed to be dispensed without straining. The other two are made by percolation with cold water, the infusion of cinchona without previous maceration, a small quantity of aromatic sulphuric acid being added to the water for the purpose of rendering the alkaloids more soluble; and the infusion of wild cherry, which is allowed to macerate for one hour before percolation.

Fig. 7.

Infusion Mug (home-made).

The process of digestion is frequently used in preparing infusions, and consists in macerating the infused substance in water for a length

of time at a moderately elevated temperature, below boiling heat, the solvent powers of the menstruum being thereby increased.

Another process of making infusions is frequently adopted, that of diluting fluid extracts with water. This plan, as a general rule, is a bad one, and not to be justified unless the active principles of the drug were equally soluble in alcohol and in water, which would very rarely be the case; it should never be followed when an official infusion is prescribed.

℞.
Potass. brom., ℥ss;
Inf. gent. comp., f℥viij.
Ft. solutio.
Sig A dessert-spoonful every 4 hours. G. M.

℞.
Ext. pilocarpi fld., fʒj;
Inf. buchu, f℥vss.
Misce.
Sig. Two table-spoonfuls every 4 hours. A. R. L.

℞.
Potass. chlor., ʒss;
Inf. rosæ comp., f℥iv.
Ft. gargarisma.
Sig. Use as directed. V. T.

℞.
Tr. aconit. rad., fʒss;
Inf. digitalis, f℥iv.
Misce.
Sig. A table-spoonful every 4 hours. W. K.

Decocta (Decoctions).—Decoctions are liquid preparations made by boiling drugs with water. These, like infusions, are not permanent preparations, being decomposed even more quickly than infusions. Many substances yield their soluble portions more readily and completely to the continued action of boiling water than if the temperature is lower, and therefore, where haste is important or where the active principles of the drug are with difficulty extracted, decoction is preferable to infusion. Many drugs, however, are injured by heat, a portion of their active principles being either destroyed or rendered inert, while at the same time the decoction becomes loaded with starchy and gummy matters that have no medicinal activity. Decoctions are perhaps more used as domestic remedies than they are prescribed by physicians. While there is a general formula given in the Pharmacopœia for the preparation of decoctions, there are only two which are official: these are decoction of cetraria and compound decoction of sarsaparilla.

The official general formula is as follows:

An ordinary decoction, the strength of which is not directed by the physician nor specified by the Pharmacopœia, shall be prepared by the following formula:

Take of
The substance, coarsely comminuted, ten parts, 10;
Water, a sufficient quantity to make one hundred parts, 100.

Put the substance into a suitable vessel provided with a cover; pour

upon it one hundred (100) parts of cold water; cover it well, and boil for fifteen minutes; then let it cool to about 45° C. (113° F.); strain the liquid, and pass through the strainer enough cold water to make the product weigh one hundred (100) parts.

Caution.—The strength of the decoctions of energetic or powerful substances should be specially prescribed by the physician.

The following are prescriptions for decoctions:

℞.

Hydrarg. chlor. cor.,	gr. j;
Potassii iodid.,	ʒij;
Decoct. sarsap. comp.,	Oj.
Ft. decoctio.	

Sig. Two tablespoonfuls 3 times a day.

F. F. M.

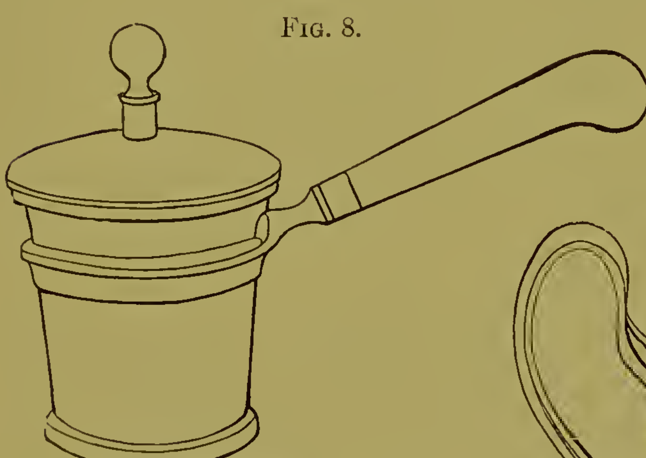
℞.

Ext. aloes. aq.,	ʒj;
Myrrhæ,	
Croci,	*āā.* gr. xlv;
Potass. carb.,	ʒss;
Ext. glycyrrhiz.,	ʒiv;
Tinct. card. comp.,	fʒiv;
Aquæ, q. s. ft.	f℥viij.
Ft. decoctio.	

Sig. A tablespoonful at night.

V. T.

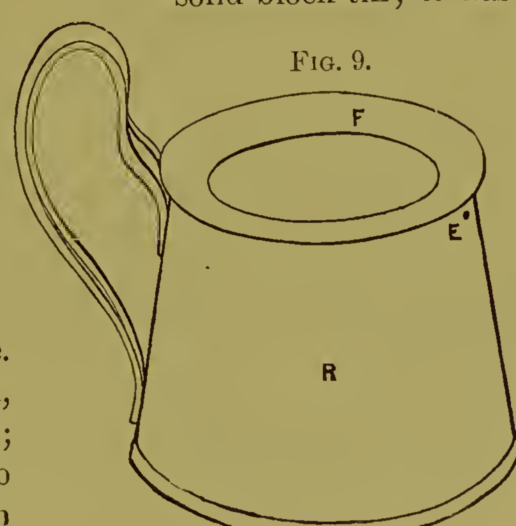
FIG. 8.



Block-tin Decoction Vessel.

Figs. 8 and 9 show apparatus for preparing decoctions. Fig. 8 represents a vessel made of solid block tin; it has a cover and a long wooden handle. The drug is placed in the vessel, covered with water, and heated; if care is necessary to prevent too much heat, the vessel is heated in the water-bath R (Fig. 9), which is kept nearly full of water.

FIG. 9.



Brass Water-bath.

Aceta (Vinegars).—The medicated vinegars of the Pharmacopœia are solutions of the active principles of drugs in vinegar or acetic acid. Vinegar is a solvent of many substances that are insoluble in water. It is a good solvent of alkaloids, which it converts into acetates, and thereby perhaps renders them more active without essentially modify-

ing their remedial action. In consequence of the variable strength of vinegar, and at the same time of its containing impurities and vegetable principles that are very liable to decomposition, the official vinegars are directed to be made with diluted acetic acid, and are thereby rendered much more uniform and stable.

There are four vinegars official—namely, those of lobelia, opium, sanguinaria, and squill; the strength of each of these is 10 per cent. of the drug, and they are all directed to be made by percolation. These preparations are not very frequently prescribed, but the vinegar of squill is largely used in preparing the syrup of squill, which is a popular remedy extensively employed.

When it is undesirable to introduce alcohol into the system—which would occur if tinctures or fluid extracts were used—or when a small quantity of acid is needed, the vinegars are useful preparations. They are usually prescribed in combinations somewhat similar to those in the following formulas:

℞.	
Morph. acet.,	gr. j;
Acet. scillæ,	f℥ss;
Syr. ipecac.,	f℥j;
Syr. tolu., q. s. ft.	f℥iv.
M. Ft. solutio.	
Sig. A tea-spoonful when the cough is troublesome.	
	V.

℞.	
Acet. opii,	fʒj;
Acet. lobeliæ,	f℥j;
Syr. senegæ,	f℥ss;
Syrupi, q. s. ft.	f℥iv.
M. Ft. mistura.	
Sig. A tea-spoonful 3 or 4 times a day.	
	W.

Alcoholic Liquids made by Percolation or Maceration.

Tincturæ (Tinctures).—Tinctures, according to the Pharmacopœia, are alcoholic or hydro-alcoholic solutions of medicinal substances. Alcohol is perhaps the best solvent of the active principles of most vegetable drugs, dissolving active principles that are not soluble or are slightly soluble in water, while it does not dissolve various inert substances that are soluble in water; thus, essential oils, resins, or oleoresins require strong alcohol as the solvent, being practically insoluble in water. On the other hand, diluted alcohol—*i. e.* alcohol diluted with an equal volume of water—is used in preparing many of the tinctures, in preference to strong alcohol, since it dissolves more of the active principles which are soluble in water, and many drugs contain principles which are most soluble in diluted alcohol; as, for example, drugs which contain tannin or extractive matter, or the natural salts of the organic alkaloids combined with essential oils or resin; in such cases alcohol diluted with water would be the most proper solvent.

Diluted alcohol contains a sufficient quantity of alcohol to preserve

preparations made with it from change or decomposition, is cheaper, and has the further advantage of giving less alcohol in the dose.

Active medicines, or those of which the dose is small, are very conveniently administered in tinctures; the amount of alcohol in them is inappreciable, but in the tinctures of the weaker medicines the amount of alcohol to be given is in many cases so great as to be objectionable, and other means of presenting the medicines is desirable; in such cases the fluid extracts are often available.

Tinctures have always been popular as medicines, and of fifty-one tinctures official in the United States Pharmaeopœia of 1820, forty-two are still official in the present Pharmacopœia.

Most of the tinctures are directed to be made by percolation, the drugs, in powder, having been previously allowed to macerate for a short time; when the process is skilfully performed the result is satisfactory and leaves nothing to be desired. The following is a list of the tinctures directed to be prepared in this manner :

Tincture of aconite,
" arnica-flowers,
" arnica-root,
" bitter orange-peel,
" sweet orange-peel,
" belladonna,
" bryonia,
Compound tincture of catechu,
Tincture of chirata,
" cimicifuga,
" cinchona,
Compound tincture of cinchona,
Tincture of cinnamon,
" colchicum,
" saffron,
" conium,
" cubeb,
" digitalis,
" nutgall,
" calendula,
" calumba,
" Indian cannabis,
" cantharides,
" capsicum,
" cardamom,
Compound tincture of cardamom,
Tincture of nux vomica,
" opium,
Deodorized tincture of opium,
Tincture of physostigma,
" pyrethrum,
" quassia,
" rhubarb,
Aromatic tincture of rhubarb,
Sweet tincture of rhubarb,
Tincture of sanguinaria,
" squill,
" serpentaria,
" gelsemium,
Compound tincture of gentian,
Tincture of hops,
" hydrastis,
" hyoscyamus,
" ignatia,
" krameria,
Compound tincture of lavender,
Tincture of lobelia,
" matico,
" musk,
" myrrh,
" stramonium,
" sumbul,
" valerian,
Ammoniated tincture of valerian,
Tincture of vanilla,
" veratrum viride,
" ginger.

In the hands of inexperienced operators the plan of maceration with frequent agitation will be found more satisfactory. In this method,

however, there will always be more or less loss, since there will always be a portion of the liquid retained in the dregs, however thoroughly they may be expressed after maceration.

Gums and gum-resins, owing to their adhesive nature, are not easily percolated, and consequently the tinctures of these are directed to be made by maceration; and seven days is the length of time specified for most of them.

The following tinctures are thus prepared, and after maceration are separated from the dregs by filtration through paper:

Tincture of aloes,	Tincture of guaiac,
" aloes and myrrh,	Ammoniated tincture of guaiac,
" asafetida,	Tincture of myrrh,
" benzoin,	Camphorated tincture of opium,
Compound tincture of benzoin,	Deodorized tincture of opium.

The same length of time is not necessary for such substances as are almost wholly soluble in alcohol; thus, tincture of kino and tincture of green soap are directed to macerate only until the respective drugs are dissolved. In the case of tinctures of fresh herbs a longer maceration is necessary, and the Pharmacopœia has extended the time to fourteen days.

The following, although classed among the tinctures, are simply solutions of substances that are perfectly soluble, and therefore would more properly be called alcoholic solutions:

Tincture of acetate of iron,	Tincture of iodine,
" chloride of iron,	" tolu.

Tinctures are prescribed so largely, and differ so much in physical properties, that no general rules can be formulated for their proper combination. Resinous tinctures should not be directed to be mixed with aqueous solutions without providing for the suspension of the precipitated resin by the use of sufficient acacia; hydro-alcoholic tinctures and resinous tinctures should not be mixed together for the same reason. Mucilage of acacia and strong syrup are precipitated if mixed with tinctures containing strong alcohol.

The following prescriptions exhibit some of the forms in which tinctures are prescribed:

℞.
Tinct. digital., f℥ss;
Ext. ergotæ fld., f℥iiss.
M.
Sig. A tea-spoonful thrice daily.
B.

℞.
Tinct. strophanthi, f℥j.
Sig. Five drops 3 times daily.
F.

℞.
Tinct. krameriæ, fʒiv;
Tinct. opii, fʒij;
Mist. cretæ, q. s. ft. f℥iij.
M.
Sig. A tea-spoonful 3 times a day.

℞.
Tinct. guaiaci, f℥ss;
Ext. cannabis, gr. xvj;
Syr. tolut., f℥j;
Pulv. acaciæ, q. s.
Aquæ, q. s. ft. f℥ij.
M. Ft. mistura.
Sig. A tea-spoonful in water.
F. F. V.

℞.
Tinct. iodi co., f℥ss;
Aq. ammon. fort., fʒss.
M.
Sig. Apply externally with a camel's-hair brush. M. B. M.

℞.
Tinct. cantharidis, fʒij;
Tinct. ferri chlor., fʒvj.
M.
Sig. Twenty drops in water through a glass tube, thrice daily.
H. C. W.

℞.
Tinct. gelsemii, fʒj;
Tinct. belladon., fʒij.
M.
Sig. Fifteen drops at bedtime.
A. R. T.

Vina Medicata (Medicated Wines).—Medicated wines are solutions in wine of the soluble principles of medicinal substances. They contain less alcohol than tinctures, and are therefore less stimulating, while there is enough alcohol in them to render them much more permanent than infusions or decoctions. Most wines are liable to undergo decomposition, more especially when imbued with the soluble principle of vegetable drugs. White wine is the kind directed to be used in making the wines of the Pharmacopœia, and in order to make these preparations more permanent its alcoholic strength is increased by the addition of 1 part of alcohol to 7 parts of wine; this preparation is known as Vinum Album Fortius, or stronger white wine, and is required to contain not less than 20 per cent., nor more than 25 per cent., of alcohol.

In the Pharmacopœia previous to 1880 the imported wines sherry and port were official, sherry being used as the menstruum for preparing the medicated wines; but no directions were given respecting the amount of alcohol contained in it, and consequently the medicated wines as usually found were very variable in alcoholic strength, and very often had not enough alcohol to preserve them. But in 1880 the committee of revision decided not to recognize any special variety of wine, and adopted the titles "vinum album" (white wine) and "vinum rubrum" (red wine), and permitted any wine to be used, whether imported or not, provided it was sufficiently pure and had the required alcoholic strength.

There are fourteen official wines; of these, three are not medicated—viz. white wine, stronger white wine, and red wine; four are prepared by percolation—aromatic wine and the wines of colchicum-root, ergot, and rhubarb; three are prepared by maceration—viz. the wines of aloes, colchicum-seed, and opium; and the remaining four are made by simple solution or admixture; these are bitter wine of iron, wines of antimony, citrate of iron, and ipecac.

The following illustrations show the use of medicated wines:

℞.
Morph. sulph., gr. j;
Vin. colchici, fʒj;
Magnesiæ, ʒj;
Aq. menth. pip., f℥iv.
Misce.
Sig. A table-spoonful thrice daily.
W. T. B.

℞.
Tinct. nuc. vom., fʒiv;
Syr. tolut., f℥ij;
Vin. ferri, q. s. ft. f℥iv.
Misce.
Sig. A tea-spoonful after meals.
B. B. N.

℞.
Syr. scillæ, f℥j;
Syr. picis liq., f℥iss;
Tinct. opii, fʒij;
Vin. antimonii, f℥ss.
Ft. mistura.
Sig. A tea-spoonful at night.
W. V. K.

℞.
Sod. borat., gr. ij;
Vin. opii, gtt. v;
Aqua dest., f℥j.
Ft. collyrium.
Sig. Drop in the eye as directed.
M. L. V.

Extracta Fluida (Fluid Extracts).—This class of preparations is the largest and one of the most important, if not the most important one, in the United States Pharmacopœia. Having been made official for the first time in 1850, when seven were introduced, they have so increased in popularity and number that formulas for preparing seventy-nine are given in the U. S. P. of 1880, and for fifty-two others in the National Formulary, in addition to which there have been placed upon the market by various manufacturers an endless variety of fluid extracts of almost all the vegetable drugs that are known to medical science.

Fluid extracts are alcoholic or hydro-alcoholic solutions of the soluble principles of vegetable drugs, of such strength that 1000 grammes of drug are fully represented by 1 litre of fluid extract, or 1 gramme by a cubic centimetre (a millilitre). This is a slight change of strength from the Pharmacopœia of 1870. At that time the fluid extracts were to be made so that each minim represented one grain of the drug; but as there exists no fixed relation between minim and grain, it was thought best to adopt the metric system, in which one gramme is the exact weight of one cubic centimetre of distilled water;

to express this relation more clearly the term fluigram has been proposed. This involved a change of 5 per cent., the strength being thereby rendered 5 per cent. weaker—a change not sufficient to be appreciated in dosage.

The great advantage of fluid extracts over other liquid preparations of the same drug consists in their concentration and consequent convenience, their permanence, and in the uniform relation of their strength to the drugs from which they are prepared. They are much more concentrated than tinctures, and are thereby rendered more portable; at the same time the dose required is much smaller and contains less alcohol, which in many cases is contraindicated therapeutically. Inasmuch as they fully represent the drugs from which they are prepared by containing all their soluble principles, they are in very many cases superior to the various alkaloids and active principles, which are generally only partial representatives of the medicinal activity of these drugs.

The subject of menstrua (the liquids used to extract the soluble principles) has been carefully studied, and very many experiments have been made with the view of ascertaining the best menstruum for each individual fluid extract. Some drugs require much stronger alcohol to exhaust them than others, and with all, when an alcoholic menstruum is used, a sufficient amount is taken to exhaust the drug thoroughly, and enough alcohol is allowed to remain in the finished extract to render it permanent; this latter object is still further ensured by the addition in some cases of a small quantity of glycerin to the menstruum.

Some drugs—as, for example, triticum and castanea—are best exhausted by boiling water, and in these cases, after exhausting the drugs by percolation, the liquid is evaporated to the proper degree, and to preserve it a sufficient quantity of alcohol is added to make the finished product contain 20 per cent.

The official process for making fluid extracts is by percolation, and, as described in the Pharmacopœia, consists in subjecting a substance in powder, contained in a vessel called a percolator, to the solvent action of a menstruum in such a manner that the liquid as it passes through the powder in its descent to the recipient shall be charged with the soluble portion of it, and be free from insoluble matter. The following is given as a typical formula:

One hundred grammes of a drug reduced to the proper degree of fineness having been moistened with a specific quantity of menstruum, are carefully packed in a suitable percolator, and a sufficient quantity of menstruum added thoroughly to saturate the powder. When the liquid begins to drop from the percolator, the lower orifice is closed with a cork, and the drug is allowed to macerate for a certain time; additional menstruum is then poured on, and, the cork having been removed, perco-

lation is continued until the drug is exhausted. Ordinarily, the first 70 to 90 c.c. of liquid passing through are reserved, and the remainder, having been evaporated to the consistence of a soft extract, is dissolved in the reserved portion. A sufficient quantity of menstruum is then added to make the whole measure 100 c.c.

The value of the resulting fluid extract will of course depend upon the manner in which the prescribed directions are followed; and, with a proper selection of the drug, if the process of percolation is carefully and skilfully conducted, the results cannot fail to be satisfactory.

℞.
Ext. uvæ ursi fld., f℥j;
Ext. tritici fld., f℥ij.
Misce.
Sig. A tea-spoonful in water 3 times a day. O. K.

℞.
Potass. acet., ʒij;
Ext. buchu. fld., f℥ij.
Ft. solutio.
Sig. A tea-spoonful 4 times a day. L. L.

℞.
Ext. verat. virid. fld., f℥ss.
Sig. Two drops in water, as directed.
B. K. S.

℞.
Ext. erythroxyli fld., f℥j;
Vin. xerici,
Syr. tolut., *āā.* f℥iij.
Misce.
Sig. A tea-spoonful 4 times a day. W. B. K.

℞.
Ext. lactucæ fld., fʒvj;
Syr. scillæ, f℥iss;
Tinct. opii, f℥ss;
Syr. pruni virg., q. s. ft. f℥iv.
Misce.
Sig. A tea-spoonful when the cough is troublesome.
L. D.

℞.
Ext. rhei aromat. fld., f℥j;
Ext. aromat. fld., fʒiv;
Syrupi, f℥vij.
Misce.
Sig. A tea-spoonful 3 times a day. W. N.

℞.
Ext. aconit. fld., fʒvj;
Lin. saponis, fʒiv.
Ft. liniment.
Sig. Apply as directed.
W. N. T.

℞.
Ext. digital. fld., fʒij;
Ext. aconit. rad. fld., fʒvj.
Misce.
Sig. Two drops in water 3 times a day. V. W. M.

℞.
Ext. grindeliæ fld., fʒiv;
Aquæ font., f℥vss.
Misce.
Sig. Apply constantly to the inflamed surface.
W. R.

℞.
Ext. pilocarpi fld., fʒij;
Liq. potass. cit., f℥iij.
Misce.
Sig. A tea-spoonful every two hours.
V. M.

℞.
Potass. chlor., ʒj;
Ext. rhois glab. fld., f℥ss;
Inf. rosæ comp., q. s. ft. f℥iv.
Ft. gargarisma.
Sig. Use as a gargle, as directed.
M. B.

℞.
Acid. nitrohydrochlor. dil., fʒiij;
Ext. chiratæ fld., f℥j;
Ext. tarax. fld., q. s. ft. f℥iv.
Misce.
Sig. A tea-spoonful before meals.
G. O. M.

Ethereal Liquids made by Percolation or Maceration.

Oleoresinæ (Oleoresins).—Oleoresins are liquid preparations made by extracting from certain vegetable substances the natural oils and resins contained therein by means of percolation with ether. They are much more concentrated preparations than fluid extracts, and do not bear any fixed and definite relation to the drugs from which they are prepared, as do the fluid extracts; moreover, they do not contain exactly the same constituents as fluid extracts of the same drugs, since alcohol and ether possess different solvent powers, many substances soluble in one being insoluble in the other. They should be entirely free from the odor of ether or benzin, this latter substance being sometimes substituted for ether in making these preparations—a proceeding which is entirely unjustifiable.

Owing to the powerful and disagreeable taste and odor of the oleoresins, they are usually given enclosed in capsules of gelatin, in pills, or emulsified, so as to obtund the taste, as the prescriptions given below indicate.

The official oleo-resins are those of aspidium, capsicum, cubeb, ginger, lupulin, and pepper.

℞.
Oleoresinæ cubebæ, ♏xij.
Ft. capsulæ No. iv.
Sig. One, twice a day.
X.

℞.
Ol. terebinth.,
Oleores. aspidii, āā. fʒj;
Sodii chlorid., gr.xv;
Pulv. acaciæ, q.s.
Aquæ, q. s. ft. f℥ij.
M. ft.
Sig. Two tea-spoonfuls taken fasting.
W.

℞.
Oleores. capsici, ♏x;
Linim. saponis, f℥iv.
Sig. Apply at night, as directed.
Q. E. D.

℞.
Copaibæ,
Oleores. cubebæ, āā. f℥ij.
M. Ft. capsulæ molles No. xx.
Sig. One, 3 times a day.
V. R.

℞.
Morph. acet.,
Oleores. capsici, *āā.* gr. j ;
Pulv. camphoræ,
Ext. hyoscyami, *āā.* gr. xx.
Ft. massa et div. in pil. No. xx.
Sig. One, at night. W. R. T.

Solids.

Preparations made by Percolation or Maceration.

Extracta (Extracts).—Extracts of the Pharmacopœia are solid or semisolid preparations, prepared by extracting the soluble principles of drugs and evaporating the solutions to a proper consistence ; these solutions are prepared either by expressing the juice from the fresh plant or by extracting the soluble principles of the dried drug by means of a solvent. Most of the extracts are directed to be prepared by percolation, and the solutions thus obtained evaporated to the proper consistence by means of a water-bath. They are valuable preparations, affording the means of administering various medicines in pilular form, and when properly made preserving for a long time their virtues unimpaired. They are usually prepared either of such soft consistence as to be readily made into pills, or are reduced to dryness, so that they can be powdered. Thus, aqueous extract of aloes is a dry extract, and extract of colocynth is directed to be in powder. Some of the soft extracts are evaporated until brought to pilular consistence, such as extract of gentian or extract of rhubarb, while others contain 5 per cent. of glycerin, which makes them retain their consistence, preventing them from getting hard—such as, for example, alcoholic extract of belladonna or extract of cinchona ; the extract of malt is evaporated to the consistence of thick honey. Many of the powdered extracts found in the market, although purporting to be of full official strength, are very deficient, being either made of inferior drugs, improperly made, or damaged by heat in the process of drying.

The following is a list of official extracts, in addition to those named above : extracts of aconite, arnica-root, Indian cannabis, colchicum-root, digitalis, ergot, euonymus, glycyrrhiza, hæmatoxylon, iris, juglans, krameria, leptandra, mezereum, nux vomica, opium, physostigma, podophyllum, quassia, stramonium, taraxacum, the alcoholic extracts of conium and digitalis, the compound extract of colocynth, and pure extract of glycyrrhiza.

Formulæ illustrating the methods of prescribing extracts are appended :

℞.
Hydrarg. chlor. mit., gr. xij;
Pulv. ext. coloc. co., gr. xxiv;
Ext. hyoscyam., gr. xviij.
Ft. massa et div. in pil. No. xij.
Sig. One, at night.

℞.
Ferri redact., gr. xx;
Ext. nuc. vom., gr. iv;
Ext. quassiæ, gr. xvj;
Pulv. sapon., gr. viij.
Ft. massa et div. in pil. No. xij.
Sig. One, after meals. V. Q.

℞.
Ext. belladon., gr. vj;
Ext. cannab. Ind., gr. viij;
Ext. ergotæ, gr. l.
Ft. massa et div. in pil. No. xvj.
Sig. One or two during the day as directed. R.

℞.
Ext. aloes, gr. vij;
Ol. carui, gtt. j;
Ext. gentianæ, gr. viij.
Ft. massa et div. in pil. No. vj.
Sig. Two, at night. V. W.

Abstracta (**Abstracts**).—Abstracts were introduced into the Pharmacopœia of 1880, and were designed with the view of taking the place of various powdered extracts that were found in the market, and which, as prepared by the different manufacturers, varied very greatly in composition and strength. These differences arose from different makers using different menstrua to exhaust the drugs, and in many cases were caused by using too great heat in their preparation during the process of drying.

Another objection to powdered extracts lies in the fact that many of them are slightly hygroscopic, and in consequence after being kept a short time they run together and become hard and tough masses which are very unmanageable.

Abstracts possess certain advantages over both extracts and fluid extracts: they are made of definite strength, 2 parts of drug being represented by 1 part of abstract, being double the strength of fluid extracts. In preparing an abstract the drug is thoroughly exhausted of soluble principles by alcohol; the tincture thus obtained, after being mixed with a portion of sugar of milk, is evaporated spontaneously at a low temperature until it becomes dry; it is then mixed with a sufficient quantity of sugar of milk to make the product weigh one-half the weight of the drug used, and reduced to a uniform fine powder. The drug is thus presented in a soluble condition, and, not being subjected to a temperature at any time exceeding 158° F., it is not injured by heat. They are permanent preparations, are very portable, and will retain their pulverulent condition indefinitely if proper precautions are taken to protect them from moist air; they should be kept in a cool place. They contain no alcohol, and can be conveniently administered

in capsules. Their definite relation to the drugs from which they are prepared is of importance and value to the physician in fixing the dose, which is just one-half that of the drug itself or of its fluid extract, while the dose of solid extracts bears no such relation to the drug and varies with each preparation.

The following abstracts are official: viz. abstracts of aconite, belladonna, conium, digitalis, hyoscyamus, ignatia, jalap, nux vomica, podophyllum, senega, and valerian.

Illustrations are appended showing the manner of prescribing abstracts. They may be administered in powders, cachets, pills, capsules, or in solution or mixtures:

℞.
Abstract. aconiti,
Pulv. sacch. lact., *āā*. gr. vj.
M. Ft. chart. No. xij.
Sig. One every 3 hours.
M.

℞. For Willie ——.
Abstract. jalapæ, gr. xv;
Hydrarg. chlor. mit.,
Pulv. aromat., *āā*. gr. v;
Pulv. sacch. lact., gr. xxx.
Fiant chart. No. xv.
Sig. One every fourth hour.
X.

℞.
Abs. belladonnæ,
Res. podophylli, *āā*. gr. vj;
Pulv. capsici, gr. xij.
M. Fiant pil. No. xxiv.
Sig. One pill at night.
H.

℞.
Abstract. nucis vom., gr. xij;
Zinci phosphid., gr. j.
Fiant capsulæ No. xij.
Sig. One, 3 times a day.
Z.

Resinæ (Resins).—The resins of the Pharmacopœia are solid preparations, consisting principally of the resinous principles either of natural oleoresins obtained as residues after distilling off their volatile oils, or of vegetable substances prepared by precipitating with water their alcoholic tinctures.

They differ from alcoholic extracts in containing only those principles which are soluble in alcohol, but insoluble in water, while alcoholic extracts contain all the principles that are soluble in alcohol.

There are five resins official: resin, the residue obtained by distilling off the volatile oil from turpentine; resin of copaiba, the residue after distilling off the volatile oil from copaiba; and the resins of jalap, podophyllum, and scammony, made by percolating the respective drugs with alcohol and precipitating the resin by the addition of water.

Resin of podophyllum is much the most important of this group of preparations: the official resins, with the exception of resin of copaiba, are hard solids, or, as usually found in pharmacy, reduced to fine

powder. Resins are nearly always prescribed in combination with other ingredients; as, for example, in the following prescriptions:

℞.
Res. podophyll., gr. iij;
Pulv. capsici, gr. vj;
Ext. belladon., gr. ss;
Pulv. sacch. lact., gr. xij.
M. Ft. pil. No. xij.
Sig. One at night.
N. S.

℞.
Res. scammon., gr. xij;
Pulv. aloes, gr. xv;
Ext. colocynth., gr. iij;
Potass. sulph., gr. ij;
Ol. caryoph., gtt. j.
M. Ft. pil. No. xij.
Sig. One or two as directed.
V. T.

Extemporaneous Preparations.

Pulveres (Powders).—Powders form a convenient method of administering many medicines, such as are not deliquescent or are not particularly offensive to the taste, and of which the doses are small.

The powders of the Pharmacopœia are all compound; that is, each one consists of two or more substances mixed together. Although volatile or deliquescent substances are not suitable for powders, it sometimes becomes necessary to prescribe them in this form; in such cases the powders should be dispensed wrapped in papers coated with wax or paraffin to protect them from the air, and if required to be kept for any length of time they should be preserved in closely-stopped bottles.

The following powders are official: viz. antimonial, aromatic, compound chalk, and compound effervescing powders, powder of ipecac and opium, and compound powders of glycyrrhiza, jalap, morphine, and rhubarb.

Powders are well suited for administration to infants and children if the ingredients are not repulsive or disagreeable to the taste. In prescriptions in which it is the intention to divide the powders into convenient doses and dispense them folded in small papers, they are distinguished by the name "chartulæ."

The following are given as illustrations of the methods of prescribing powders:

℞.
Bismuthi subnit., gr. xij;
Pepsini, gr. vj;
Pulv. sacch. lact., gr. xij.
M. Ft. pulv. et div. in chart. No. xij.
Sig. One every 3 hours.
V. N.

℞.
Hydrarg. chlor. mit., gr. iij;
Pulv. sacch. alb., gr. xij.
M. Ft. pulv. et div. in chart. No. xij.
Sig. One, 3 times a day.
M.

℞. For Elsie ——.
Quinin. sulph., gr. vj;
Sod. bicarb., gr. j;
Pulv. ext. glycyrrh.,
Pulv. sacch. alb., *āā.* gr. vj.
M. Ft. pulv. et div. in chart. No. xij.
Sig. One powder in a half-teaspoonful of syrup.

E. A. S. Y.

℞.
Abstract. bellad., gr. iij;
Pulv. opii, gr. vj;
Pulv. aromat., gr. iv;
Pulv. sacch. lact., gr. xij.
M. Ft. pulv. et div. in chart. No. xij.
Sig. One powder every 4 hours, as directed.

L.

Triturationes (Triturations).—This title has been adopted by the Pharmacopœia to signify powders prepared by triturating 1 part of a medicinal substance with 9 parts of sugar of milk. While a general formula for their preparation is given, there is only one trituration official, that of elaterin, and it furnishes a convenient form for administering this powerful remedy; but it is doubtful whether such an official preparation is desirable, and perhaps it would be better to leave such mixtures to extemporaneous prescription.

In prescription it would be desirable to combine the trituration with an aromatic to prevent griping.

℞.
Trit. elaterini, gr. vj;
Pulv. aromat.,
Pulv. sacch. alb., *āā.* gr. xij.
Ft. pulv. et. div. in chart. No. xij.
Sig. One, as directed.

V. W.

℞.
Trit. elaterini, gr. vj;
Oleores. capsici, gtt. j;
Pulv. micæ panis, gr. xij.
Ft. pulv. et div. in cachet No. xij.
Sig. One, as directed.

L. N.

Wafers or Cachets (Cachet de Pain).—Wafers are prepared by pouring a thick, smooth mixture of flour and water between greased hot polished plates or cylinders, so adjusted that a thin sheet or wafer is produced; by the rapid evaporation of the water the wafer becomes spongy in its character. When dry it is hard and brittle, but when moistened it becomes soft, tough, and slippery, and is well adapted for taking medicines in the form of powder. A powder may be conveniently administered by placing it upon a piece of moistened wafer laid upon a table-spoon, and folding the corners so as to cover it completely, when with the aid of a little water it can very readily be swallowed.

The cachet, or as sometimes called "cachet de pain," consists of two concave pieces of wafer, varying in size from $\frac{3}{4}$ inch to $1\frac{1}{8}$ inches in diameter, round or oblong in shape, in one of which the powder to

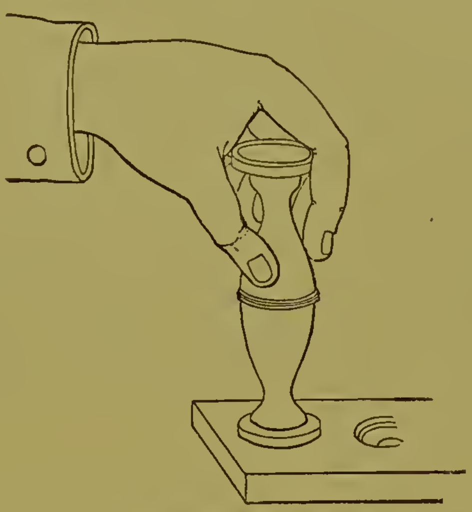
be administered is placed, and the other, having previously been moistened, is then laid over the powder and the two margins are pressed together, when they adhere and completely enclose the powder.

The apparatus used for preparing "cachets" is shown in Figs. 10, 11, and 12. In Fig. 10 the lower cachet, filled with powder, is seen,

FIG. 10.

Cachet-wetter and Funnel.

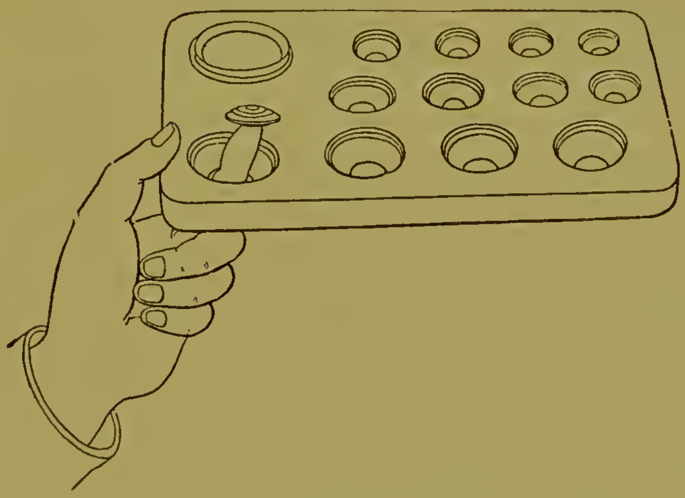
FIG. 11.



Sealing the Cachet.

above it the funnel used for the powder, and above the funnel the sealed cachet ready for use. In Fig. 11 is shown the method of sealing the cachet by pressing the upper cachet with its moistened edge upon the

FIG. 12.



Limousin's Cachet-board.

lower cachet; adhesion takes place, and the sealed cachet is pushed out of its bed in the board, as seen in Fig. 12.

Upon being floated upon a table-spoonful of water or dipped for a few seconds in water the cachet becomes soft and slippery, and, like the wet wafer, can easily be swallowed with a draught of water, the wafer when wet passing into the œsophagus imperceptibly. The advantage

of the cachet over the wafer is that no more of the enveloping material than is necessary to cover the medicine is used, and the dose can therefore be more readily swallowed, because its bulk has been reduced to the minimum.

Cachets furnish a most excellent means of administering nauseous or bitter powders, and when patients have once acquired the knack of swallowing them easily, they become very much pleased with this mode of taking medicine. Care must always be taken to explain in detail to the patient (in case the latter should not be familiar with cachets) their mode of administration, or ludicrous *faux pas* are likely to occur, such as masticating the dry cachet, or, as one patient observed to her physician on the next visit that he paid her, that she wished he would tell the apothecary not to be so particular next time to seal the medicine up "so tight in the papers," as it took a whole hour of her time to cut each one open with a pair of scissors to get the medicine out. She was very much surprised when her adviser told her that this was one of those cases in which the "papers" so called must be swallowed along with the powder.

"Cachets" may be prescribed in the following manner:

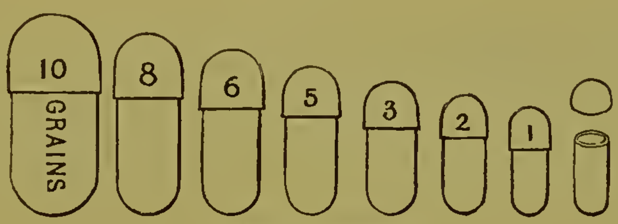
℞.
Quinin. sulph., gr. xxiv;
Ferri redacti, gr. xlviij;
Ft. pulv. et div. in "cachet" No. xxiv.
Sig. One, 3 times a day.
L. M.

℞.
Ol. croton. tig., gtt. iij;
Pulv. micæ panis (siccæ), q. s.
Ft. pulv. et div. in "cachet" No. xij.
Sig. Take two, as directed.
R.

Capsulæ (Capsules).—Capsules made of gelatin furnish a convenient method for administering nauseous or disagreeable medicines. Several kinds are in use—*hard* and *soft* capsules, which contain liquids, and *empty* capsules (cylindrical), for holding solids. Pearls are globular in shape, and differ from capsules in being *completely* filled with liquid; they thus have the advantage of being smaller in size. Ordinarily, capsules are ovoid in shape, and are prepared from a dense, hot solution of gelatin by dipping a greased bone or ivory mould into the solution, allowing the film to remain long enough to be sufficiently dry to handle, when it is dexterously pulled off; the empty capsule is then held upright and filled with the liquid medicine, and sealed by dropping some hot gelatin solution on the opening. A small air-space is left inside the capsule by this method of filling. The capsule upon drying becomes hard, and is impervious to the various medicines that can be administered in this form. The addition of glycerin to the solution of gelatin renders the capsule permanently soft. Empty

capsules are cylindrical in shape, with rounded ends, and are made in two pieces, one of which is of slightly larger diameter and fits closely over the other. The medicinal ingredient in the form of powder or pill mass is placed in the smaller cylinder, and the shorter cylinder is pressed down over it like a cap. When a liquid is used, if the edge of the lower cylinder is slightly moistened with water, it may be made

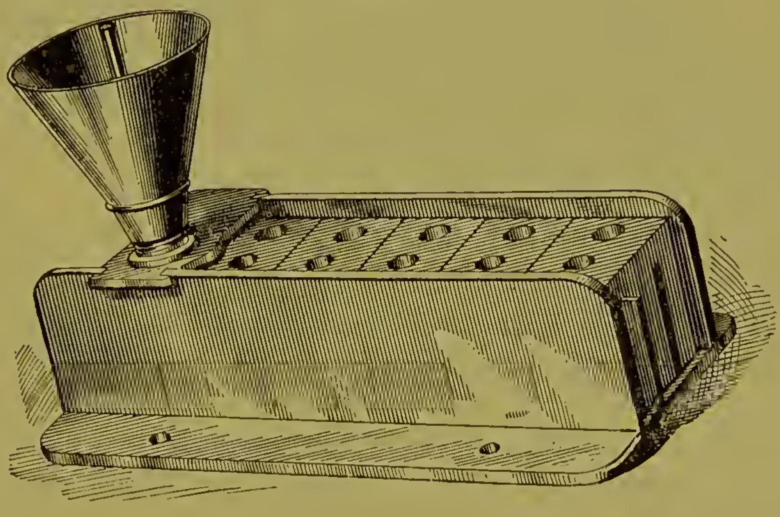
Fig. 13.



Empty Capsules.

to adhere closely to the upper piece and form a perfect joint, thus preventing leakage. Empty capsules are shown in Fig. 13, arranged

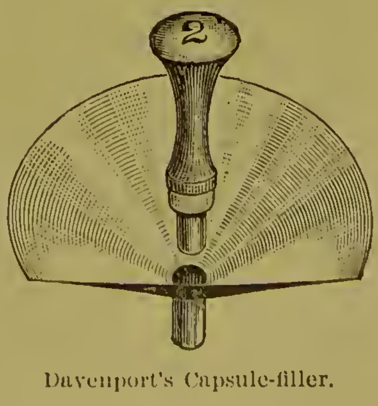
Fig. 14.



Acme Capsule-filler.

according to their respective sizes. Owing to their extended employment, they are now manufactured on an enormous scale. For filling empty capsules several machines have been invented. The "Acme" (Fig. 14) is very ingenious and simple. A block of wood holding twelve capsules is pushed into a nickel-plated metal frame which bears an inclined plane set on edge. The empty capsules having been placed in the holes, the first capsule is run under the funnel and filled; then the block is pushed to the right and No. 2 is filled, and so on until the six on the side are filled. As they are

Fig. 15.



Davenport's Capsule-filler.

pushed along they are raised out of their beds by the inclined plane, when they may be easily capped. Davenport's capsule-filler (Fig. 15) is very simple, and when small quantities are needed it answers very well. The mouth of the funnel is inserted into the capsule, and the powder, having been introduced into the funnel, is "rammed" into the capsule with the plunger. The cap is then put on, and all is complete.

The following prescriptions illustrate methods of directing medicines to be dispensed in capsules:

℞.
Ol. picis liq., ʒj.
In capsulis div. No. xij.
Sig. One, 3 times a day.
W. B.

℞.
Quinin. sulph., gr. xxiv;
Ext. nucis vomicæ, gr. xij;
Acid. arsenios, gr. j.
Ft. capsul. No. xxiv.
Sig. One, twice a day.
V. R.

℞.
Antifebrin., ʒij.
In capsulis div. No. xxx.
Sig. One or two capsules every half-hour.
D. B.

Tabellæ (Tablet-triturates).—Tablet-triturates are small disk-shaped bodies prepared by moistening medicated powders with a highly volatile liquid, then moulding the moistened powder, ejecting the tablet, and allowing the liquid to evaporate, when the tablets retain their shape. The basis of tablet-triturates is mostly finely-powdered sugar. They were first suggested by Dr. Robert M. Fuller in 1878, and are now largely employed. They possess advantages over any other method of administering solid substances, such as powders, pills, or capsules. They are much more readily and conveniently taken, and possess all the solubility of powders, which perhaps are the most inconvenient and disagreeable form of administering medicines. Capsules are more convenient than powders, but have the disadvantage of being less soluble, while pills are sometimes so insoluble as to pass through the alimentary canal without disintegration. Well-made tablet-triturates will disintegrate immediately.

The apparatus for making these tablets consists of two plates of metal, hard rubber, or other suitable material, one of them being perforated with holes having the size of the required tablets, the other having pegs upon it so situated that (when in position) these shall exactly fit into the holes in the perforated plate. The pegs must be longer than the thickness of the perforated plate, and at each end of the plate is a longer and larger peg, which, fitting into a corresponding

hole in the perforated plate, serves as a guide and secures the proper position of the plates when used.

In making tablets the medicated powder is made into a paste by moistening it with alcohol or other suitable liquid, and pressed with a spatula into the holes of the perforated plate (Fig. 16) which has previously been laid upon a pill-tile or glass plate. When the holes are

Fig. 16.

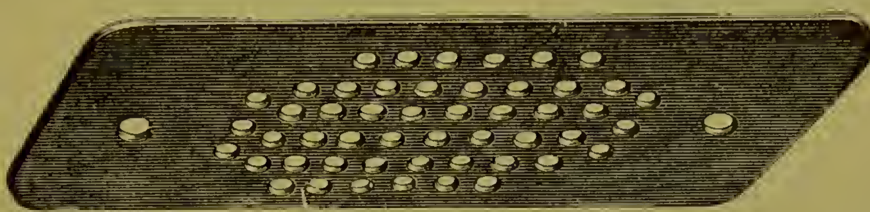


Fig. 17.

Tablet Machine.

filled, the excess of paste is cleaned off and the plate is placed over the one having the pegs (Fig. 17), and so adjusted that the larger pegs shall enter the corresponding holes in the perforated plate, which latter plate is then pressed gently down until the plates are brought into contact, and each of the smaller pegs, pushing out the paste from its corresponding hole, will have a tablet resting upon it. The plate is then set aside until the liquid has evaporated and the tablets are sufficiently dried to be removed; this requires but two or three minutes, when, after being thoroughly dried, they are ready for use. Tablets for hypodermic applications may be conveniently prepared by this process, care being taken that the ingredients are thoroughly mixed and that the quantities in each tablet are accurately proportioned.

Tablets are made by this process from powdered sugar of milk, powdered sugar, and a small quantity of acacia, without medication; these have been called blank tablets. They are used by adding the proper amount of medicated material in solution, such as an alcoholic fluid extract, and allowing the liquid to evaporate. When dried they are called tablet-saturates.

Following are given prescriptions for tablet-triturates and tablet-saturates:

℞.
Hyoscyaminæ pur., gr. $\frac{1}{60}$.
Ft. tabella trituratio.
Mitte tales xx.
Sig. One at night. W. W.

℞.
Ext. aconit. fld., ♏j.
Ft. tabella saturatio.
Mitte tales x.
Sig. Take one, every 4 hours.
A. K.

℞.
Acid. arseniosi, gr. $\frac{1}{100}$.
Ft. tabella trituratio.
Mitte tales xl.
Sig. Two, 3 times a day. N. L.

℞.
Ex. digital. fld., ♏j.
Ft. tabella saturatio.
Mitte tales xij.
Sig. Take two, every 3 hours.
W. C.

Trochisci (Troches).—Troches or lozenges are small, solid masses, generally of cylindrical or flattened shape; they are intended to be dissolved in the mouth slowly and gradually, and furnish a pleasant and convenient means of administering many remedies. Only such medicines as are used in small doses, and which have no particularly disagreeable taste, can be appropriately given in this form. Lozenges are made by beating the basis containing the medicinal agent, which is usually finely-powdered white sugar, known technically as "lozenge sugar," with sufficient mucilage of tragacanth to form a soft mass. This is rolled out on a board with a rolling-pin into a flat, smooth cake, and when of the proper thickness it is cut with a lozenge-punch or cutter. (See Figs. 18 and 19.) There are sixteen official formulas for troches, as follows: troches of bicarbonate of sodium, catechu, chalk, chlorate of potassium, chloride of ammonium, cubeb, ginger, glycyrrhiza and opium, ipecac, iron, krameria, magnesia, morphine and ipecac, peppermint, santoninate of sodium, and tannic acid. Morell Mackenzie has introduced many formulæ for lozenges for throat affections which have for their basis currant-fruit paste; these have been largely used. Physicians may usually have lozenges made for them extemporaneously if the pharmacist is given an hour or two for their preparation; they require a short time to dry properly.

Fig. 18.

Fig. 19.

Lozenge-cutter, with Die.

Bacilli are cylindrical lozenges made by cutting the lozenge mass, rolled into a soft cylinder, on a pill-machine; the well-known Wistar's and licorice lozenges of the manufacturers closely resemble bacilli.

The following are formulas for troches:

℞.
Res. guaiaci, gr. lxx;
Pulv. tragacanth., gr. vij;
Pulv. sacch. alb., gr. xxx;
Gelationis ribis rub., q. s.
Fiant troch. No. xxxv.
Sig. One lozenge every 2 hours.
V. K.

℞.
Bismuth. subnit., ʒij;
Cretæ præparat., ʒiv;
Ol. caryoph., gtt. j;
Ol. cinnam. zeylan., gtt. j;
Pulv. sacch. alb.,
Muc. tragacanth., *āā.* q. s.
Fiant troch. No. xl.
Sig. One lozenge, 4 times a day.
R. T.

Confectiones (Confections).—Confections are soft solids made by incorporating medicinal substances with saccharine matter, with the object of furnishing an agreeable and convenient mode of administration. Only two confections are official: confection of rose and confection of senna. Confection of rose is almost exclusively used as a vehicle for other medicines, but is also used as an excipient in making pills, to give proper consistence to the mass. Confection of senna is an agreeable and efficient laxative. Both of these confections are elegant preparations when properly made, and keep well when carefully secured.

℞.
Sulphur. sub., ʒj;
Conf. sennæ, ʒiij.
M.
Sig. A tea-spoonful at night.
V. N.

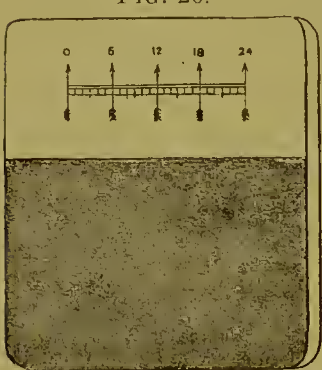
℞.
Pulv. antimonial., gr. ix;
Pulv. res. guaiac., gr. xij;
Pulv. aloes. pur., gr. ix;
Pulv. myrrh., gr. vj.
Conf. rosæ, q. s.
Ft. massa et div. in pil. No. xij.
Sig. One, 3 times a day.
K. K.

Pilulæ (Pills).—Pills are globular or spherical solid bodies of such size that they may be conveniently swallowed; their weight varies from a grain or less to five or six grains when made of ordinary vegetable drugs, and to eight or ten grains when made of heavy mineral substances. The method of administration of medicines in pilular form is a very popular one, pills being cheap, compact, portable, convenient, and by the great majority of persons easily taken. Such medicines as are nauseous or disagreeable to the taste, and of which the dose is small, are conveniently given in this form. Pill-masses, while being sufficiently soft and plastic to be made into pill form, must be hard enough to retain their shape when thus made. Liquids or soft substances can be made into pilular form by the addition of dry inert powders, while hard substances, such as gum-resins, extracts, etc., require the addition

of a small quantity of water or of alcohol, and powders or substances which are wanting in adhesive qualities can be rendered sufficiently adhesive by the addition of mucilage, glycerin, glucose, syrup, or other viscid or tenacious liquid. A judicious selection of excipients to give the proper consistence to articles used in making pills requires good judgment, a practical knowledge of the physical properties and peculiarities of the various substances prescribed, and practical experience. One of the best excipients for general use consists of a mucilage made by gently heating a mixture of 1 part of tragacanth and 8 parts of glycerin until a uniform jelly is produced.

When the pill-mass has been properly made, it is rolled into a cylinder upon the pill-tile (Fig. 20), the best form of tile being that shown in Fig. 21, which is made of plate-glass, having the greater

FIG. 20.



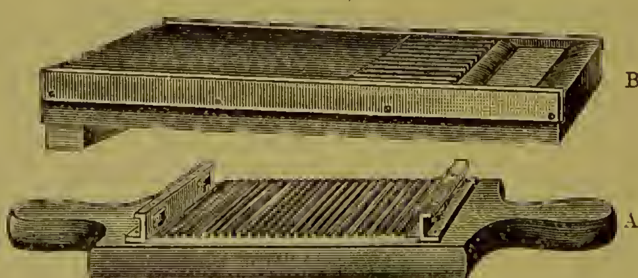
Pill-tile.

FIG. 21.

Rolling a Pill-cylinder.

portion roughened, so as to prevent the slipping of the cylinder during rolling. When pills are to be made in larger quantities, it will be found more satisfactory to use a pill-machine. This consists of two walnut boards, A, B, as shown in Fig. 22 and Fig. 23. These have

FIGS. 22, 23.



Pill-machine.

plates made of brass, with grooves in them. The pill-cylinder is laid across the grooves in B, and when A is pressed down upon it the pill-cylinder will be cut into pieces, which may then be rolled into pills.

With the view of covering their taste, as well as of rendering them more sightly, pills are covered with various substances, such as sugar,

gelatin, tolu, gold-leaf, silver-leaf, etc. The coating with sugar is usually done by machinery, and pills thus coated are made in immense quantities. Processes suitable for the retail pharmacist for coating pills with sugar on the small scale are not satisfactory, while coating with gelatin, tolu, and gold- or silver-leaf can be readily and quickly performed.

The advantages of coated pills are: they are more sightly; their disagreeable taste is concealed; they are protected from the air, and therefore keep better, being less liable to undergo change; and they retain their shape better. On the other hand, they have the disadvantage of being slower in their action in consequence of being less soluble, and sometimes their activity is greatly impaired by the use of too much heat in drying the pills preparatory to the process of coating.

Compressed pills are now very largely used; they are made by compressing dry powders into moulds by suitable machines, the force applied being sufficient to make them cohere. The advantages of this form of pill are, that, having no foreign substances or excipients mixed with the medicines employed, they are more easily and quickly dissolved in the stomach, they are handsome in appearance, and usually are more easily swallowed than ordinary pills.

Machines for making compressed pills are manufactured to be operated either by hand or steam-power, and are so arranged that pills of any size, from official troches or lozenges to hypodermic tablets, can be made very rapidly.

The following prescriptions illustrate various combinations used in prescribing pills:

℞.
Aloe purif., gr. xij;
Mass. hydrarg., gr. vj;
Res. podoph., gr. iss.
M. Ft. pil. No. vj.
Sig. One or two at night.
E. V. W.

℞.
Ferri sulph., gr. xxiv;
Potass. carb., gr. xvj;
Pulv. sacch. alb., gr. vj;
Glyc. tragacanth., q. s.
Ft. pil. No. xij.
Sig. One, 3 times a day. W. M.

℞
Pulv. opii,
Ammon. carb., *āā*. gr. x;
Pulv. camphoræ, gr. xx.
M. Ft. pil. compressæ No. x.
Sig. One at night.
M. A.

℞.
Morph. sulph., gr. iij;
Ext. colch. acet., gr. xx;
Res. podoph., gr. ij.
Ft. massa et div. in pil. No. xij, et cum saccharo tege.
Sig. One at night. L. W.

℞.
Aloini, gr. vj;
Strychninæ, gr. ss;
Ext. belladon., gr. iv.
Ft. massa et div. in pil. No. xxx.
Sig. One, twice a day.
C. L. B.

℞.
Ferri valer., gr. iij;
Zinci valer., gr. xxiv;
Ext. sumbul., gr. vj.
Ft. massa et div. in pil. No. xij, et fol. argenteo involve.
Sig. One, 3 times a day.
L. E. T.

Cerata (Cerates).—Cerates are unctuous preparations consisting of wax, mixed with oils, fatty substances, or resins, and of such consistence that at ordinary temperatures they can be readily spread upon linen or muslin, and yet so firm that they will not melt or run when applied to the skin. In this respect they differ from ointments, which are appropriately used for inunction, and become liquefied by the heat of the body when thus applied. The lard, oils, or other fatty substances from which they are prepared should be entirely free from rancidity, and as a general rule the temperature used in making them should not be higher nor continued for a longer time than is necessary to mix the ingredients thoroughly, any decomposition by heat, which would tend to render them irritating, being thereby avoided; and when prepared they should be kept as much secluded from exposure to air as possible. When, however, the virtues of some ingredient are best extracted by heat, or when an excess of liquid is to be evaporated—as, for example, in making cantharides cerate or savine cerate—a greater and more continued heat is required. Cerates prepared with white wax become rancid sooner and more readily than those prepared with yellow wax, and the cerate known as simple cerate would probably be a better preparation if made with yellow wax; but white simple cerate has been popularly known for so long a time that a colored preparation to take its place would not be received with favor.

℞.
Extracti stramonii, ʒss;
Cerati, ℥j.
Misce secundum artem.

In compounding a prescription like the foregoing, in which an extract is directed to be mixed with a cerate, the extract should first be rubbed in a warm mortar with a little water or alcohol until reduced to a uniform, soft consistence, and then mixed with a small quantity of the cerate until thoroughly incorporated, after which the remainder of the cerate should be gradually added and the whole rubbed together until a uniform mixture is produced.

Prescriptions are frequently written directing liquids to be mixed

with cerates where the amount of liquid is excessive or greater than can be retained by the cerates; in such cases, after the cerates are saturated, the remainder is usually thrown away. Cerates, being of harder consistence than ointments, will not retain as much fluid, but the amount taken up may be increased by the addition of a small quantity of lard or oil if the softer consistence thus produced is not objectionable.

The following cerates are official: viz. cerate, cerates of camphor, cantharides, extract of cantharides, resin, savine, spermaceti, and subacetate of lead.

Cerates may be prescribed as follows:

℞.
Cerat. cantharid., q. s.
Spread a blister upon adhesive plaster 3 × 7 in.
W. V.

℞.
Liq. plumbi subacet., f℥j;
Cerat. camphoræ, ℥iv.
Misce sec. art.
Sig. Apply to the part night and morning.
N. T.

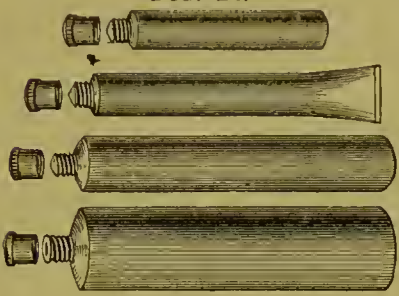
Unguenta (Ointments).—Ointments are unctuous preparations made from oils, lard, petrolatum, or other fatty substances, and of such consistence that when applied to the skin they become liquefied by the heat of the body, thus differing in consistence from cerates. In preparing and preserving ointments the same precautions which were given respecting cerates in regard to heat, rancidity, and exposure to air should be observed. Ointments are prepared either by melting the ingredients together by heat or by incorporating the medicating substance, which is generally insoluble in the fatty matter, by trituration. The mixture may be made with a mortar and pestle, or, if the substance is in fine powder, it may be mixed with the lard or other fat upon an ointment slab by the aid of a spatula; in either case care must be taken to have the ingredients thoroughly mixed and the ointment smooth and uniform. The single exception to these methods is the ointment of nitrate of mercury, in which lard oil and nitrate of mercury are heated together, when a chemical reaction takes place, resulting in the change of the olein of the oil into elaidin, with which the nitrate of mercury is subsequently mixed. In making or dispensing this ointment, as well as those containing tannic or other free acids, an iron spatula should not be used.

The following official ointments are made by fusion: ointment, diachylon, mezereum, and tar ointments, and the ointment of rose-water; while the following are made by incorporation: alkaline sulphur, belladonna, chrysarobin, iodine, iodoform, mercurial, nutgall, stramonium, sulphur, and veratrine ointments, and the ointments of ammoniated mer-

cury, carbolic acid, carbonate of lead, iodide of potassium, oxide of zinc, red oxide of mercury, tannic acid, and yellow oxide of mercury.

Soft ointments may be very satisfactorily dispensed in *collapsible tubes*, like those used for holding artists' oil colors. (See Fig. 24.) The ointment is easily introduced in the large open end of the tube, and this then closed by folding the soft metal sides together; when it is desired to use some of the ointment the screw cap is removed and sufficient is pressed out. The advantages of this mode of dispensing are that the ointment is preserved from change by preventing the access of air, waste is avoided, as well as the greasing and soiling of furniture due to the passage of fatty oils through the ordinary wooden boxes that are often used to dispense ointments in.

Fig. 24.



Lanolin (the purified fat from sheep's wool), petrolatum, cosmoline, and vaseline (purified products from petroleum residues), have all been used as substitutes for lard and animal fats as bases for ointments; but unless otherwise specified, it is always understood that when ointments are prescribed purified lard is the basis.

The following methods of prescribing ointments are given as illustrations:

℞.
Ung. hydrarg. nit., ʒiij;
Ung. aq. rosæ, ʒv.
M. Ft. unguent.
Sig. Apply to the eyelid at night.
N. T.

℞.
Ung. stramonii, gr. xx;
Pulv. gallæ, gr. xxx;
Adipis, ℥ss.
M. Ft. unguent.
Sig. Apply as directed.
W. B.

℞.
Ext. belladon., gr. vj;
Petrolati, ʒiv.
M. Ft. unguent.
Sig. Apply as directed.
L. V.

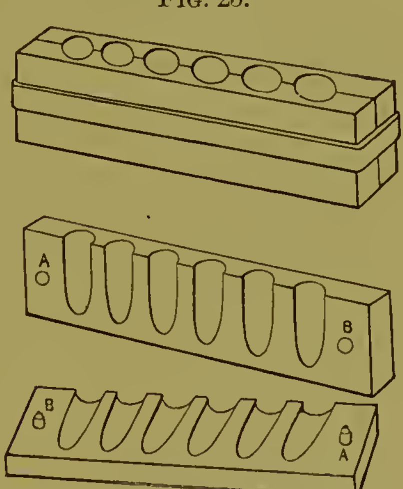
℞.
Hydrarg. ammon., gr. v;
Glycerini, gtt. v;
Adip. benz., ℥ss.
M. Ft. unguent.
Sig. Use as directed.
L. B.

℞.
Veratrinæ, gr. x;
Lanolini, gr. xxx.
M. Ft. unguent.
Sig. Rub on the part as directed.
M. M.

℞.
Ung. acidi gallici, ℥ss;
Ung. zinci oxidi, ℥iss.
M. Ft. unguent.
Sig. Apply night and morning.
D. B.

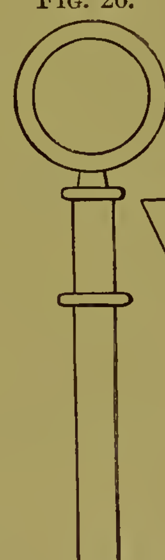
Suppositoria (Suppositories).—Suppositories may be described as solid medicated compounds designed to be introduced into the rectum, urethra, or vagina, serving the purposes of ordinary clysters or injections, over which they have the advantages of greater comfort and cleanliness, as well as being more easily introduced; their consistence is such that while they retain their shape at ordinary temperatures, they will readily melt at the temperature of the body. The material best adapted for use as the vehicle appears to be the oil of theobroma (butter of cacao), which possesses in an eminent degree both of the above requirements. A mixture of gelatin and glycerin has been successfully used as a vehicle, more particularly for urethral suppositories, butter of cacao being too brittle for convenient use. Glycerin suppositories, containing 95 per cent. of glycerin, are largely used. The size of suppositories has been gradually diminishing; formerly they were made to weigh from one to two drachms or more; in the Pharmacopœia of 1870 they were directed to be made to weigh thirty grains, while in the present Pharmacopœia their weight is directed to be about fifteen grains. In order that suppositories may be uniform in size and shape, they are generally run or pressed into moulds, which in the absence of metallic moulds may be made of sized paper folded into the shape of cones. They may also be made by hand by grating cacao butter with an ordinary grater, and then mixing in the medicinal ingredients in a mortar, adding, if necessary in cold weather, a drop or two of olive oil: the whole is to be made into a mass with a pestle and then rolled out in a cylinder on a pill-tile. The cylinder is then cut into suitable

Fig. 25.



Divided Suppository-mould.

Fig. 26.



Suppositor.

Fig. 27.

lengths for a suppository, and one of the ends is pointed by pressing it into shape gently with the finger and thumb.

Although no special suppositories are official, a general formula is

given for their preparation, in which the oil of theobroma is directed to be melted and then mixed with the medicinal portion. Fig. 25 shows a mould for making suppositories. It is made of brass, and the parts are held in place by a rubber band. Machines are now in use whereby handsomely finished suppositories are rapidly made by cold compression, the ingredients having previously been thoroughly mixed. Figs. 26 and 27 show a simple apparatus for introducing suppositories into the rectum. Fig. 27 is hollow, with its lower end reduced in diameter, so that the suppository fits snugly when dropped into it. This end is oiled and introduced into the rectum, the piston (Fig. 26) being used to push the suppository into its place.

Some of the modes of prescribing suppositories are as follows. Some allowance should be made for waste in moulding when the quantity of the basis is specified:

℞.
Ext. hyoscyam., gr. iv;
Ol. theobrom., q. s.
Fiat massa et div. in suppositoria No. iv (*āā.* gr. xv).
Sig. One at night.
W. L.

℞.
Morph. sulph., gr. $\frac{1}{2}$;
Ol. theobrom., q. s.
Fiat massa et div. in suppos. No. iv (*āā.* gr. xv).
Sig. One at night. T. T.

℞.
Iodoformi, gr. xvj;
Acid. carbolici, gtt. iv;
Ol. theobromæ, q. s.
Ft. massa et div. in suppos. No. viij (*āā.* gr. xv).
Sig. One, 3 times a day.
E. M. D.

℞.
Acidi stearici, gr. lxxx;
Sodii carb., gr. xl;
Glycerini, ℥ij.
Misce. et fiant suppos. No. xij (*āā.* gr. lxxv).
Sig. One as required. M. L. T.

℞.
Ext. stramonii, gr. xij;
Plumbi acet., gr. xviij;
Creasoti, gtt. vj;
Ol. theobromæ, q. s.
Fiat massa et div. in suppositoria No. xij (*āā.* gr. xv).
Sig. Use as directed. R. T.

℞.
Quininæ sulph., gr. xvj;
Ol. theobrom., q. s.
Fiat massa et div. in suppos. No. iv (*āā.* gr. xv).
Sig. One, twice a day. B. H.

℞.
Ext. opii, gr. vj;
Hydrarg. chlor. mit., gr. xx;
Ol. theobrom., q. s.
Ft. massa et div. in suppos. No. xij.
Sig. One, 3 times a day.
W. W.

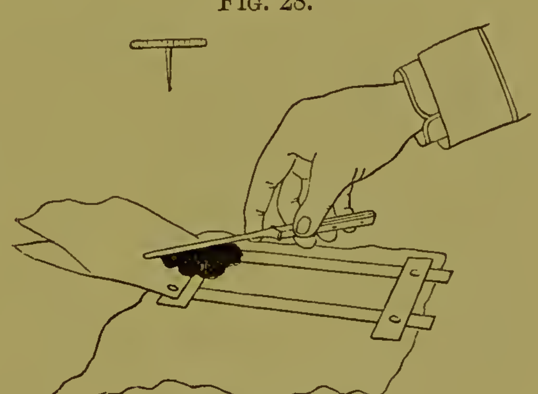
℞.
Ext. ergotæ, ʒij;
Ol. theobromæ, q. s.
Ft. massa et div. in suppos. No. xij (*āā.* gr. xxx).
Sig. One at night.
E. M. C.

Emplastra (Plasters).—The word "plaster" is applied both to the material of which plasters are made and to the spread plaster itself. Plasters are intended for external application, and the consistence of the material is such that it requires the aid of heat in spreading it, but is sufficiently soft and adhesive at the temperature of the body to adhere when applied to the skin. There is one exception to this definition of official plasters, and that is isinglass plaster—or court plaster, as it is familiarly called—which is a spread plaster, and does not become adhesive when warmed, but requires to be moistened with water before application.

The most ordinary basis for official plasters is lead plaster, while some owe their adhesiveness and consistence to resinous substances and others to gum-resins. Plasters are usually spread upon leather or muslin, sometimes upon paper. Sheepskin is the kind of skin commonly used; when greater pliability or softness is required buckskin or chamois-skin may be employed. A plaster when spread should be so firm as not to run or melt at the heat of the body, and yet should be soft, pliable, and adhesive. When long kept, plasters become hard and brittle and lose their adhesive properties.

The official plasters have in a great measure been superseded by ready-spread plasters having a rubber basis, which are manufactured of a great variety of kinds and in immense quantities. These plasters are pliable and adhesive, do not change their consistence, and retain their medicinal properties unimpaired for an indefinite length of time. Unfortunately, the process is not adapted to the wants and purposes of the pharmacist, and cannot be used advantageously except upon a very large scale.

Fig. 28.



Spreading a Plaster.

Fig. 28 illustrates the spreading of a plaster. The skin is laid upon a smooth, flat surface of wood and strips of writing-paper are tacked on, as shown, preferably with thumb-tacks. The melted plaster is poured on one end, and it is uniformly spread over the surface with a previously-warmed spatula.

The following list comprises all the official plasters: ammoniac, ammoniac with mercury, arnica, asafetida, belladonna, capsicum, iron, galbanum, mercurial, isinglass, opium, Burgundy pitch, Canada pitch, pitch with cantharides, lead, resin, and soap.

Prescriptions for plasters are usually written in the following forms:

℞.
Emp. belladonnæ.
Spread a breast-plaster 8 inches in diameter. J. S.

℞.
Emp. pic. burg., 4×6.
Dust upon the surface sufficient powdered opium to adhere.
W. L. G.

℞.
Emp. capsici. 4×6.
Sig. Apply upon back, as directed.
K. T.

℞.
Spread a soap-plaster 2×8 inches, with a half-inch margin. D. D.

Chartæ (Papers).—"Papers" of the Pharmacopœia are preparations intended chiefly for external application, and consist of paper saturated or coated with medicinal substances. Only three "papers" are official: cantharides paper, mustard paper, and nitrate-of-potassium paper; the last, in addition to being used externally in the shape of moxas, is much used in cases of asthma. It is sometimes called asthma-paper, and frequently affords relief. It is used by burning the paper and inhaling the fumes while burning.

Chartæ may be ordered in the following manner:

℞.
Chartæ sinapis., j.
3×4.
Sig. Apply immediately. W. V.

℞.
Chartæ cantharidis, j.
For the left ear, as per pattern.
Sig. Apply at once. E. S.

Incompatibility.

Incompatibility is that condition in medicines which results from the admixture of ingredients which are unsuited to each other. It is obvious that incompatibility may arise from a great variety of causes; and it would be impossible to enumerate all of the cases of incompatibility which are likely to occur in compounding medicines; indeed, it is impossible to give even a fair approximation of them. It must not be assumed that incompatibility is always unintentional: the decomposition of a chemical salt is sometimes the object sought by the prescriber. Nothing but a thorough knowledge of the physical and chemical properties of all of the substances which enter into the Materia Medica would absolutely prevent the prescribing of incompatible substances.

In order to grasp more clearly the various phases of incompatibility the subject is divided into three classes: 1. Chemical incompatibility; 2. Physical incompatibility; 3. Therapeutic incompatibility.

1. **Chemical Incompatibility.**—By this is meant the incompatibility which is due to chemical action, which results in decomposition of one or more of the ingredients of the prescription. This form of incompatibility is very common, and may be produced as follows:

1. *Through the precipitation of an insoluble salt by the addition of one solution or salt to another.*

2. *By the decomposition of a salt in solution containing a base united with a weak or volatile acid by the addition of a stronger acid.*

3. *Through the decomposition of a salt in solution containing an acid united with a weak or volatile base by the addition of a strong alkali.*

4. *By the precipitation of alkaloidal salts by the addition to their solutions of alkalies, alkaline salts, or salts which produce insoluble compounds.*

5. *By the unsightly discoloration or precipitation due to the formation of inky compounds, produced by bringing astringent solutions containing tannin or similar substances in contact with ferric salts.*

6. *By the decomposition of a substance without precipitation, because of the formation of products which are soluble in the resulting liquid.*

7. *By the decomposition of a salt in solutions containing a base united with a weak or volatile acid by the addition of a salt containing a stronger acid.*

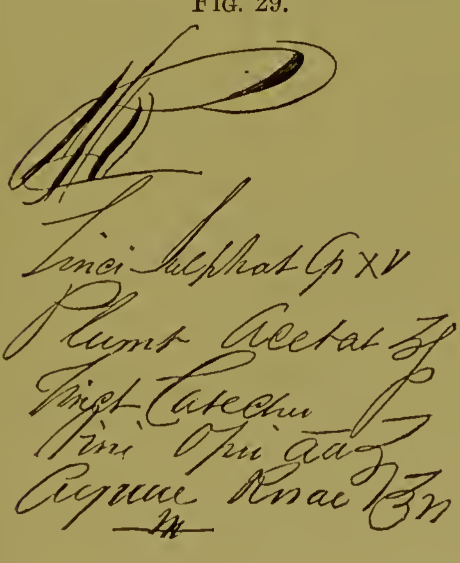
8. *By the decomposition of an oxidizing agent through the addition of organic or readily oxidizable substances, or by the destructive decomposition of some of the ingredients, with the formation of gases, resulting from the explosive action of the substances entering into the prescription.*

9. *By chemical action in the prescription, which results in an unexpected change in the color of the liquid.*

1. Through the precipitation of an insoluble salt by the addition of one solution or salt to another.

This is one of the most frequent forms of incompatibility. As before stated, some prescriptions are purposely constructed to yield precipitates; injections used in gonorrhœa are often so constructed (See Fig. 29). In this case the precipitated lead sulphate is the important factor. In prescription Fig. 30 a good illustration is afforded of this kind of incompatibility. Sulphate of quinine forms with soluble acetates the insoluble quinine acetate; it is very doubtful whether any of the quinine acetate would be decomposed in the stomach, and a pharmacist would be justified in calling the attention of the prescriber to the character of the precipitate.

Fig. 29.



℞. Fig. 30.

Quin. sulph.,	ʒss ;
Acid. sulph. dil.,	gtt. xx ;
Tinct. card. comp.,	fʒij ;
Liq. ammon. acet.,	f℥iij ;
Aquæ, q. s. ad	f℥iv.

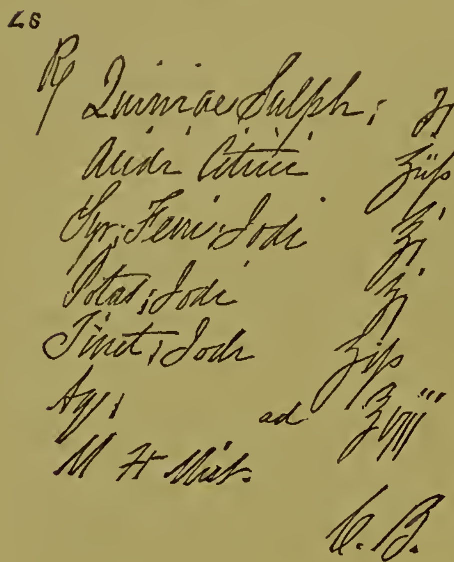
M.

Sig. Take a tea-spoonful 3 times a day.

G. W. N.

In prescription Fig. 31 a complicated reaction occurs. The citric acid is present in sufficient quantity to dissolve the quinine sulphate, but the iodides are decomposed, and the result is the formation of insoluble iodide of quinine. The prescription, which is a facsimile, shows other evidence of lack of skill and judgment. The combinations of alkaloids and iodides or bromides should be avoided.

Fig. 31.



℞. Fig. 32.

Sodii salicylat.,	ʒss ;
Acid. hydrochlor. dil.,	fʒiv ;
Syr. limon.,	f℥ss ;
Aquæ, q. s. ft.	f℥ij.

Ft. solutio.

Sig. A tea-spoonful 3 times a day.

L. L.

Prescription Fig. 32 shows a common form of this kind of incompatibility. The soluble salicylates are decomposed by acids, and salicylic acid, being almost insoluble in water, is thrown out of solution. The diluted hydrochloric acid should be prescribed separately.

2. By the decomposition of a salt in solution containing a base united with a weak or volatile acid, by the addition of a stronger acid.

℞. Fig. 33.

Ammon. carb.,	ʒss ;
Tr. opii camph.,	
Syr. scillæ,	*āā.* f℥ij.

Ft. mistura.

Sig. A tea-spoonful 3 times a day.

V. R.

Prescriptions having this fault are very common. In the illustration given (Fig. 33) the fact that syrup of squill contains acetic acid is usually overlooked, and if the pharmacist forgets this and compounds the prescription in the usual way, decomposition takes place in the bottle, the acid acts on the ammonium carbonate, and carbonic acid is liberated in sufficient quantity to burst the bottle. If the escape of gas is allowed to proceed quietly in the mortar before bottling, no harm will probably ensue. But if it is desirable to give an alkali in such a mixture, liquor potassæ, liquor sodæ, or liquor ammoniæ would be much preferable.

3. Through the decomposition of a salt in solution containing an acid united with a weak or volatile base, by the addition of a strong alkali.

This form of incompatibility is not so common as that last considered. It is seen in Fig. 34, which is a form of caustic sometimes

prescribed. When the strong alkalies are brought in contact with the ammonium carbonate, gaseous ammonia is liberated, until the latter is finally entirely dissipated.

Fig. 34.

℞.
Calcis, ʒiv;
Ammon. carb., ʒss;
Potassæ, ʒij.
Ft. pulv.
Sig. Use cautiously, as directed.
M.

4. By the precipitation of alkaloidal salts by the addition to their solutions of alkalies, alkaline salts, or salts which produce insoluble compounds.

This represents one of the most dangerous forms of incompatibility that can occur. It is well known that the alkaloids are the most powerful and toxic of all of the agents used in the Materia Medica. The alkaloids, morphine, strychnine, quinine, etc., in their pure alkaloidal condition are soluble in oils, alcohol, ether, chloroform, benzine, and other similar solvents, and are mostly insoluble in water. As their aqueous solutions are the most useful in medicine, chemists have been compelled from their introduction to "salify" them, as it is termed; by this is meant the addition of the proper molecular portion of acid to convert the alkaloid into a salt; thus from morphine, by the addition of sulphuric, hydrochloric, and acetic acids, the sulphate, muriate, and acetate of morphine are formed. Now, it requires 10,000 parts of cold water to dissolve 1 part of the alkaloid morphine, but only 24 parts of the same liquid to dissolve 1 part of sulphate of morphine or muriate of morphine, and only half of this quantity, or 12 parts of cold water, to dissolve 1 part of acetate of morphine; thus it follows by the laws of chemical action that if an aqueous solution of an alkaloidal salt is brought in contact with free alkali, decomposition takes place; the acid used in salifying the alkaloid combines with the added alkali, and the alkaloid in its pure state is precipitated. If the solution is strong and the alkali in excess, the precipitation is immediate, and would be apt to be noticed at once by the apothecary; but the alkaloids are rarely given internally in strong solution, and the particular danger lies in the fact that the precipitation of a colorless, transparent alkaloid takes place very gradually in the prescription, and without attracting any attention from the patient after it has left the hands of the pharmacist. The patient is likely in such cases to get no effect from the morphine in the first doses of the medicine, but when the last tea-spoonful is swallowed the quantity of morphine, which should have been distributed equally and the proper amount taken with each dose, *is all taken at once*, and death is likely to ensue. Several cases have been reported in which serious results have followed; and whenever such a prescription is received by a pharmacist, it is his duty to place what is known as a "shake-well" label upon the bottle; but as these labels are often disregarded through carelessness of the

patient, it is never safe to trust to such a course, and such prescriptions should never be written.

The soluble bromides and iodides form with many of the alkaloidal salts bromides and iodides which are insoluble, and hence they should never be prescribed together; the taking of the accompanying prescription (Fig. 35) caused the death of a lady some years ago in Great Britain.

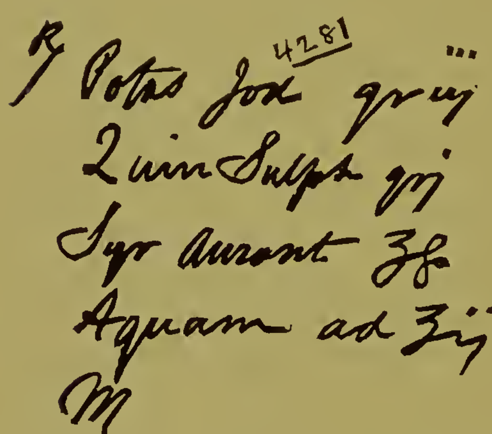
FIG. 35.

℞.	
Strychniæ sulph.,	gr. j;
Potassii bromid.,	ʒvij;
Aquæ, q. s. ft.	f℥viij.
M. Ft. solutio.	

Sig. Take a tea-spoonful 3 times a day. W. R.

For an hour or two after this prescription is prepared there are no signs whatever of decomposition, but after standing for a greater length of time a precipitate of colorless crystals forms in the bottom of the bottle, and in the case above noted the patient took the last tea-spoonful of the mixture with nearly the whole quantity of the strychnine. The pharmacist who compounded the prescription was ignorant of the chemical reaction which took place, or he might have saved her life by directing the mixture to be shaken. Fig. 36 is a facsimile of a one-dose prescription in which the chemical reaction takes place, with the formation of quinine iodide; no danger, however, can occur in the administration of this dose, for none of the ingredients are poisonous in the dose ordered.

FIG. 36.



5. By the unsightly discoloration or precipitation due to the formation of inky compounds, produced by bringing astringent solutions containing tannin or similar substances in contact with ferric salts.

Instances of incompatibility of this class are very frequent; indeed, it is difficult to avoid the formation of inky precipitates, owing to the almost universal presence of tannin in vegetable substances. Fig. 37 illustrates a prescription of this kind. The cinchotannic acid in the cinchona forms an insoluble inky compound with ferric chloride, and the tannate of iron produced communicates a blackish appearance to the mixture which renders it very unsightly.

FIG. 37.

℞.	
Tinct. ferri chlor.,	fʒij;
Ext. cinchon. fld.,	f℥ss;
Syr. tolut.,	f℥iss;
Aquæ, q. s. ft.	f℥iv.
M. Ft. solutio.	

A tea-spoonful 3 times a day. V. T.

Astringent drugs usually owe

their astringency to some form of tannin, and it is therefore safest to avoid combining iron salts with such preparations.

6. By the decomposition of a substance without precipitation, because of the formation of products which are soluble in the resulting liquid.

It must not be supposed that chemical decomposition does not take place when substances are brought in contact, because there is no *outward indication* of a change. Precipitation, it is true, is a common evidence of decomposition, but decomposition may take place with the effect of producing *soluble* compounds, or at least such as are not plainly visible; such a prescription may be seen in Fig. 38. In this case the free alkali will attack the chloral hydrate, decompose it, and produce soluble compounds, some of which are volatile, and the prescription gradually loses its strength.

Fig. 38.

℞.	
Chloral. hydrat.,	℥ss;
Liq. potassæ,	fʒiv;
Potassii brom.,	ʒij;
Syr. zingib.,	f℥iv.
M.	

Sig. A tea-spoonful at night.
W. M.

Alkalies are known to act on some of the alkaloidal drugs injuriously, and it is said that fluid extract of ipecac loses its emetic power if combined with free alkali. Fortunately, this kind of incompatibility is not likely to produce serious effects, as instances of the decomposition-products becoming more poisonous than the original substances are rare.

7. By the decomposition of a salt in solution containing a base united with a weak or volatile acid, by the addition of a salt containing a stronger acid.

This kind of incompatibility resembles very much that treated of in paragraph 2, but on account of the decomposition being produced by a salt instead of an acid, the cause of the difficulty is more liable to escape notice. Two illustrations (Fig. 39 and Fig. 40) are appended, in which explosions occurred, after the mixtures were placed in bottles ready for dispensing. In Fig. 39 the natural acid salts present, or more probably the acidity of the extract of taraxacum (which increases with the age of the extract) was the cause of the explosive action. The course which would be likely to be followed by the pharmacist would be to rub the extract with the liquids until the whole mixture is smooth, and then the solid ingredients would be incorporated gradually, and the mixture dispensed without a suspicion that upon

Fig. 39.

℞.	
Pulv. rhei,	ʒss;
Magnes. carb.,	ʒij;
Ext. taraxaci,	℥iv;
Tinct. gent. comp.,	fʒij;
Aquæ,	ad f℥vj.
M. Ft. mistura.	

Sig. A tea-spoonful 3 times a day.
L. F. T.

standing the carbonate would be gradually decomposed by the acids present. And when sufficient carbonic acid gas had accumulated the cork would be blown out of the bottle or the bottle itself burst into fragments. If the acidity of the extract be first overcome by neutralizing it with a few drops of any simple alkaline liquid, the difficulty is overcome. In Fig. 40 a very different form is shown. This case calls for special knowledge. Syrup of ferric chloride owes its preservation and effectiveness largely to the presence of an acid salt, together with a slight excess of hydrochloric acid; and when the prescription is allowed to stand tightly corked for a short time, an explosion is certain to occur, owing to the decomposition of the ammonium carbonate and the liberation of carbonic acid. In this case the alkaline salt should not be dispensed in combination.

FIG. 40.

℞.
Ext. pulsatillæ fld., gtt xv;
Ext. digital. fld., f℥j;
Liq. potas. arsen., gtt x;
Ammonii carb., ʒij;
Syr. ferri chlorid., ad f℥iv.
Misce.
Sig. Half a tea-spoonful 3 times a day. N. N.

8. By the decomposition of an oxidizing agent through the addition of organic and readily oxidizable substances, or by the destructive decomposition of some of the ingredients, with the formation of gases resulting from the explosive action of the substances entering into the prescription.

This form of incompatibility occurs frequently, notwithstanding the many warnings that have been issued in the various professional journals, both medical and pharmaceutical. Two substances are responsible for nearly all of the accidents that occur in this way—potassium chlorate and potassium permanganate. They both readily part with their oxygen, and cautious treatment must be the rule if accidents are to be avoided. The safest course is to establish the habit of prescribing all such substances by themselves, without attempting combinations, except those of a very simple character. Fig. 41 exhibits one of these prescriptions. It exploded, notwithstanding the fact that great caution was observed in mixing the ingredients.

FIG. 41.

℞.
Calcii hypophos.,
Potassii chlor., *āā.* ʒss.
M. Ft. pulv. No. vj.
Sig. One to be taken 3 times a day. V. Q. L.

The hypophosphites, even in solution, have been known to explode violently, and in one case a workman in a large chemical laboratory was killed from an explosion resulting from the evaporation of a concentrated hypophosphite solution, and the cause for it has never been satisfactorily explained. But when two bodies known to evolve large quantities of gas under the influence of chemical action, like the two in the above prescription, are ordered, it is proper for the pharmacist

promptly to decline to compound the mixture. These substances may be powdered separately, and mixed together cautiously on paper with a spatula, and yet explode simply upon standing. Chlorate of potassium can be mixed with sugar without difficulty by mingling them with a spatula, if they have been dried previously and finely powdered; but care must be taken not to strike such mixtures powerfully with a pestle in a mortar, for the concussion is often sufficient to cause explosions.

Fig. 42.

℞.
Ext. nuc. vom., gr. ij;
Ext. aloes. aq., gr. xij;
Potas. permang., gr. xij.
M. Ft. pil. No. xij.
Sig. One, 3 times a day.
B.

Fig. 42 illustrates a prescription for pills which exploded after being compounded.

9. By chemical action in the prescription, which results in an unexpected change in the color of the liquid.

Very frequently chemical action is indicated by a change in the color of a liquid prescription. If this occurs after it has left the apothecary's hands, it is sure to occasion remark, and sometimes alarm, on the part of the patient, who is led to believe that some error in compounding has produced the change in color. Tact and judgment should be used by the physician in accounting for these changes, otherwise the reputation of the pharmacist may suffer from an unjust accusation. Mixtures of guaiac containing spirit of nitrous ether or a trace of nitric acid become blue upon standing a short time. This has led many patients to think that the pharmacist has by mistake introduced some copper into the prescription. A few days' or weeks' exposure to the air will sometimes change the character of a substance, so that a prescription put up with the fresh substance will have a different appearance from one compounded from the same substance a week or a month later. Rhubarb, for instance, contains resinous principles and chrysophanic acid; these are affected by alkalies, the reddish-brown color changing to a deep purple. This may be noticed taking place very gradually in the official compound powder of rhubarb. When the rhubarb, magnesia, and ginger are first mixed together the mixture is of a light fawn color, but on standing a few months, particularly if one of the powders has not been perfectly dry, the color changes to a rose color. This is due to the action of the alkali magnesia upon the resinous principles of the rhubarb. The change in color produced when an alkaline solution is added to a liquid preparation of rhubarb —the infusion, for instance—causing it to become dark red, illustrates the rapid action of the alkali upon these principles. Then, again, the coloring matter in many drugs and preparations is discharged by bleaching agents—chlorine, sunlight, bromine, sulphurous acid, etc. etc. Tincture of iodine may have its color removed

by various methods, as the addition of water of ammonia, carbolic acid, and sodium hyposulphite. Incidentally, it might be mentioned that the attempt to refine the tincture of iodine, by taking away its objectionable feature of staining the skin, results in taking away the iodine itself, for it is no longer present in the free state, and in the case of the addition of ammonia the physician might as well prescribe the external application of a solution of iodate and iodide of ammonium.

It would be impossible in the space allotted to this subject to enumerate all of the possible changes in color that are likely to occur in prescriptions. It may be mentioned, however, that acids brighten the red vegetable colors or give them an orange tint, while alkalies cause them to assume a brown or green color; yellow vegetable colors are darkened or turned brown by the addition of alkalies, acids restoring the yellow color, or having in the first place little or no effect upon the original yellow solution. Green vegetable colors are often changed to yellow with acids, alkalies giving them a yellowish-brown color. Blue and violet vegetable colors are reddened by acids, and either become brown when alkalies are added, or, as in the well-known litmus, become blue again.

It is well to observe the changes in the color of prescriptions due to chemical action, but, as a rule, the medicinal activity of substances is not impaired by the change.

Physical Incompatibility.—By this term is meant the condition that is produced by bringing substances into contact which, through the action of physical forces, are dissociated. It differs from chemical incompatibility by the absence of chemical action, and the evidences of physical incompatibility in liquid prescriptions are mostly shown in the precipitation of some of the principles which were in solution in the original liquids. These principles may be active or inert, and thus physical incompatibility may result in the frustration of the intentions of the prescriber, or it may produce consequences which have no significance whatever. It is on the accurate judgment of the apothecary in such matters that the most dependence must be placed, for he must have sufficient knowledge of the physical properties of the various salts, solutions, and preparations to be able to detect almost instantly the cause of precipitation in a mixture, and apply a remedy which will in no way affect the intention of the prescriber, but at the same time supply the demand for satisfactory pharmaceutical preparations. A good illustration is afforded by Fig. 43, for in this case the valuable portion of the prescription would stick resolutely to the sides of the bottle, and the object of the prescription would be entirely brought to naught, if the apothecary did not come to the rescue and apply one of the simplest rules of his art—namely, the "blending of substances which are diverse into one harmonious whole." The resin of guaiac, which dis-

solved in alcohol forms the tincture, would of course be thrown out of combination when mixed with water and syrup, and the patient would simply take a tea-spoonful of diluted syrup of liquorice. In such a case the addition of a little gum acacia by the apothecary would emulsify the tincture of guaiac and hold all of the ingredients together, so that the patient would get in each tea-spoonful the proper proportion of each ingredient.

℞. FIG. 43.

Tr. guaiaci,	f℥iij ;
Syr. glycyrrhizæ,	f℥iv ;
Aquæ, q. s. ft.	f℥ij.

M.

Sig. A tea-spoonful 3 times a day.

T. S.

Fig. 44 illustrates another form of physical incompatibility. The medicated waters are mostly saturated solutions of volatile oils in water, and peppermint-water is no exception. The quantity of potassium bromide here is sufficient to destroy the affinity existing between the oil and the water, and when the solution of the bromide is effected the oil goes out of solution and the liquid becomes opaque from the drops of separated oil. If the peppermint-water be diluted with an equal bulk of water, no difficulty occurs.

℞. FIG. 44.

Potassii brom.,	ʒvj ;
Aq. menth. pip.,	f℥xij.

Ft. solutio.

Sig. Half a tea-spoonful at night.

N. G. K.

℞. FIG. 45.

Tinct. nuc. vomicæ,	f℥ss ;
Tinct. gentianæ comp.,	f℥ij ;
Tinct. cinchon. comp.,	f℥vss.

M.

Sig. A tea-spoonful 3 times a day.

G. W. T.

Fig. 45 shows a form of physical incompatibility in which the separated substance is inert; in such cases it is usual to filter the mixture. Care should always be taken by the dispenser to satisfy himself that the precipitate is inert before filtration ; if doubt exists, the prescription should always be dispensed *unfiltered* with a "Shake" label. In this prescription precipitation occurs almost immediately, but the precipitate is composed of inert matter, and is caused mainly by the fixed oil in the tincture of nux vomica and the pectinous matter in the compound tincture of gentian. Strong alcohol is the menstruum used in making the tincture of nux vomica, diluted alcohol that for the compound tincture of gentian, while that used for the compound tincture of cinchona is 80 parts of alcohol, 10 parts of water, and 10 parts of glycerin. It must follow that when such tinctures are mixed some precipitation occurs, but in this case there is sufficient alcohol and water present to retain the active principles of each in solution, and filtration is admissible. Some conception of the extent of the knowledge of the physical and chemical characteristics of medicinal substances

necessary to meet the emergencies of prescription-work is afforded by due consideration of chemical and physical incompatibility.

Therapeutical Incompatibility in prescriptions is the condition produced by the injudicious combination of medicinal substances that are therapeutically opposed to each other.

The combinations of therapeutic agents which are intended to produce certain results form appropriate subjects for consideration elsewhere in this work, and hence are not treated of in this place. The following table of incompatibles may be found useful, although necessarily brief; it is of course impossible to compile a table to cover all combinations:

Brief Summary of Incompatibilities.

Acid arsenious, with lime-water, ferric oxide, magnesia.

Acids generally, with alkalies, acetates, metallic oxides.

Albumin, with acids, alcohol, tannin, corrosive sublimate.

Alkaloidal salts generally, with tannin, alkalies, alkaline and earthy carbonates, iodine and its compounds, liquorice, strong mucilages, alkaline and ammoniated tinctures.

Alum, with alkalies and alkaline carbonates.

Ammonium bromide, with mineral acids, alkaline carbonates, chlorine, chlorate and bichromate of potassium, nitrate of silver, calomel.

Apomorphine (*hydrochlorate*), with carbonate and bicarbonate of sodium, salts of iron, iodine, and tannin.

Barium chloride, with sulphuric and phosphoric acids and their salts, tartrates, and carbonates, medicinal wines, and vegetable infusions.

Bicarbonate of sodium, with acids, tannin, salts of the metals and of the alkaloids.

Bismuth subnitrate, with tannin, sulphur, sulphide of antimony, calomel.

Chloral hydrate, with water (slow decomposition), warm water, alkaline carbonates, vegetable alkalies, ammonia salts, nitrate of mercury, calomel.

Chlorate of potassium, with mineral acids, organic substances, sulphur, carbon, calomel, iodide of iron, etc.

Chlorine (*chlorine-water*), with alkalies, alkaline carbonates, salts of ammonia, vegetable salts, nitrate of silver, lead salts, tannin, vegetable mucilages, extracts, waters, infusions, tinctures and syrups, milk, and emulsions.

Corrosive sublimate, with carbonates, lime-water, iodide of potassium, opium, vegetable infusions, tannin; but compatible with the carbonates of lime, barium, and strontium.

Digitalis, with tannin, sugar of lead, iodine, iodide of potassium, alkaline carbonates.

Golden sulphide of antimony, with bicarbonate of sodium, cream of tartar, calomel, subnitrate of bismuth.

Gum arabic, with chloride of iron, lead salts, alcohol, ethereal tinctures, borax.

Iodine, with ammonia, starch, metallic salts, fatty or essential oils, emulsions, chloral, earthy carbonates, gum arabic, tragacanth, salep.

Iron, powdered (*iron reduced by hydrogen*), with aloes, vegetable infusions and extracts, tannin, metallic and alkaloidal salts.

Iron salts, with alkaline carbonates, vegetable infusions and extracts, tannin, mucilage.

Lime-water, with acids, carbonates, ammonia, salts, metallic salts, tartrates, infusions, tinctures, tannin.

Musk, with acids, acetates, tannin, ergot of rye, metallic salts.

Nitrate of silver, with hydrochloric, sulphuric, acetic, and tartaric acids and their salts, hydrocyanic acid and its compounds, iodine, iodide and bromide of potassium, alkaline and earthy carbonates, sulphur and sulphide of antimony.

Nitrite of amyl, with tinctures, alkaline carbonates, calomel, lead salts, ferrous salts, iodide of potassium.

Opium, with alkaline carbonates, salts of the metals, tannin, iodine, chlorine-water, and nux vomica. Although opium and belladonna are supposed to be physiologically incompatible, they are often administered together with good results.

Pepsin, with alcohol, tinctures.

Permanganate of potassium, with organic substances.

Salicylic acid and salicylate of sodium, with iron salts, iodide of potassium, lime-water.

Strophanthus (*tincture*) in water undergoes hydrolysis, with formation of a toxic substance.

Tannin, with mucilage, all metallic salts, lime-water, alkaline carbonates and bicarbonates, egg-albumin, gelatin.

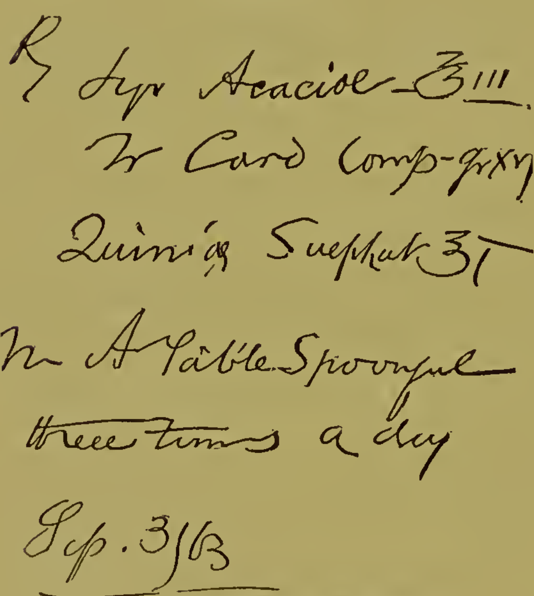
Tartar emetic, with acids, alkalies, soap, calomel, tannin, rhubarb, cinchona, gum arabic, opium.

Faults in Prescription-Writing.

The following *facsimiles* are a few selected from the author's work on *The Practice of Pharmacy*, 2d ed., p. 1017. They are presented with the view of showing some of the more prominent faults in prescription-writing. They are exact reproductions of prescriptions taken from active files, and they give some idea of the perplexities and difficulties besetting the life of the apothecary, who necessarily must be an expert in deciphering all kinds of marks on paper. Fig. 46 shows a

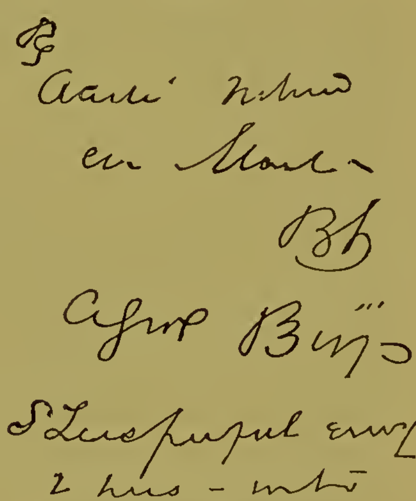
common fault; it is known as "transposition," and is caused by the habit which many physicians have of writing down the ingredients first and then placing the quantities in afterward. In this case the marks were transposed: "gr. xvj" should have followed "quiniæ sulphat," and "℥j" should have been placed after "Tr. card. comp." In a glaring case like this the apothecary would usually correct the prescription, and notify the prescriber of his action if the circumstances were such that he could see the physician personally and have the correction made without the patient's knowledge. This would be his proper course, but such action often means a loss of time that would be very inconvenient, to say the least. Of course where the supposed transposition is not so evident the duty of the pharmacist is clearly one of non-interference, and he would not be justified in dispensing the prescription without revision from the author.

Fig. 46.



Transposed Prescription.

Fig. 47.



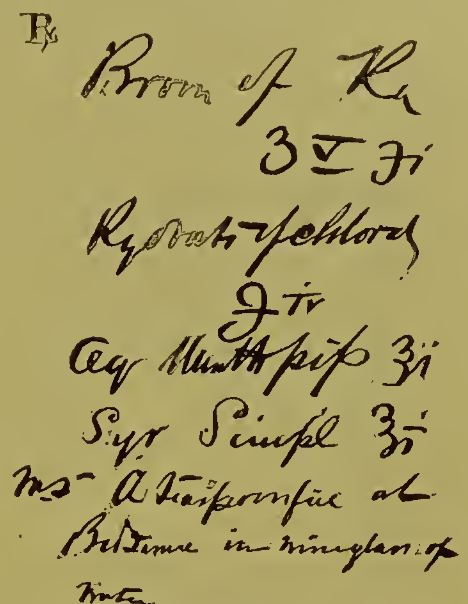
Badly-written Prescription.

In Fig. 47 is seen not only bad writing, but the fault of not using a whole line for a title, as well as that of not using official names for preparations. In this case the prescriber wanted "Acidum nitro-hydrochloricum," or, in the old nomenclature, "Acidum nitro-muriaticum," but having forgotten, or possibly having never known, the correct title, he writes "Acidi nitric et muriat., f℥ss." This fault often leads to perplexities not easily solved.

Fig. 48 shows the same fault of not using a full line for each ingredient and quantity, as well as the careless habit of employing chemical symbols for abbreviations, with the use of Latin and English terms hopelessly mixed. Fortunately, there can be no question as to the intention of the writer here: he wishes 320 grains of bromide of potassium and 80 grains of hydrate of chloral, dissolved in a mixture of

1 fl. ounce each of peppermint-water and simple syrup. Incidentally, it may be stated that the official name for "syrup" is "syrupus," and not "syrupus simplex." The name "simple" syrup has not been authorized since the Pharmacopœia of 1820. Surely seventy years is long enough to get rid of a bad habit. There is no more necessity for using the term "simple" before syrup than before alcohol, glycerin, or any other liquid used to make both simple and compound preparations, it being understood that when the word "compositus, -a, -um" is not affixed the "simple" preparation is wanted. For the same reason "simple" cerate and "simple" elixir are misnomers.

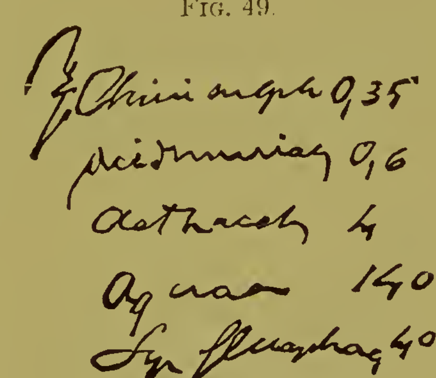
Fig. 48.



Odd Prescription.

Fig. 49 shows an involved German prescription. This is of course metric, recognized at once by the use of Arabic numerals instead of Roman characters. This prescription is not volumetric, but gravimetric, and the liquids are to be weighed instead of measured. The last ingredient is puzzling for even a bright son of the "Fatherland." The translation is, thirty-five centigrammes of sulphate of quinine (chin. sulph.), sixty centigrammes of hydrochloric acid, four grammes of acetic ether, one hundred and forty grammes of water, and forty grammes of syrup of orange-flower (fl. naphæ). The advantages of metric prescription are plainly shown here, notwithstanding the indistinctness of the ingredients, for there are no puzzling, ℈, ʒ, and ℥ marks to worry over, and the figures indicating the quantities cannot be mistaken.

Fig. 49.



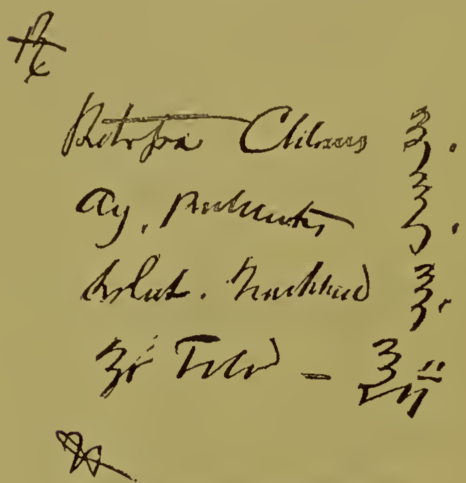
German Prescription.

Fig. 50 illustrates how "hurry" mars the appearance of a prescription. The writer has quickly scratched down the ingredients, and then in putting down the quantities, all in a row at once, has run them together, so that the whole is difficult to decipher. One ounce of potassium chlorate is to be dissolved in a mixture of one fluidounce each of boiling water and solution of morphine, and two fluidounces of syrup of tolu.

Fig. 51 shows faults of a serious character: improper abbreviation has caused loss of life a number of times. "Hyd Chlor" may mean

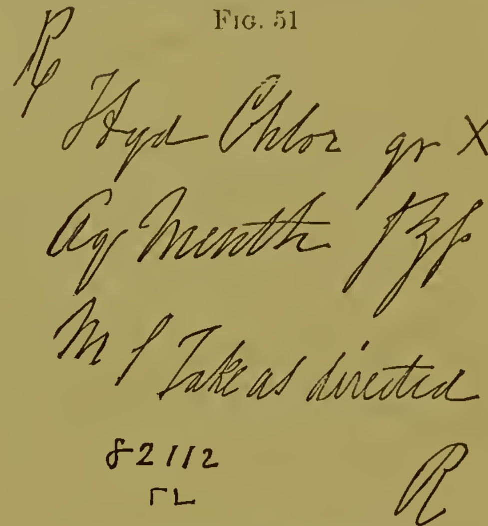
calomel, corrosive sublimate, or chloral hydrate. The dispenser who "jumps at" conclusions might imagine that a soothing draught of

Fig. 50.



Carelessly-written Prescription.

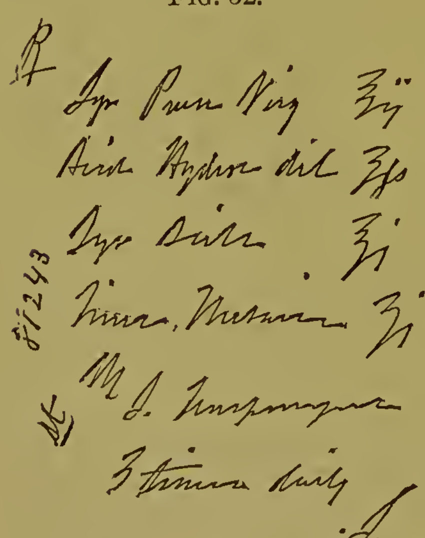
Fig. 51



Ambiguous Prescription.

chloral hydrate and mint-water was intended, and that verbal directions were given to the patient how to take it; but the careful pharmacist would ask the patient whether he wanted the directions put on the label, and what the directions are: this brings the information that it is a dose for biliousness, and the doctor said "to take the whole quantity at once." This surely does not mean that either chloral hydrate or corrosive sublimate was wanted, but calomel, and so it proved to be. Mint-water might mean either peppermint-water or spearmint-water, and a memorandum should be made of the ingredients on the prescription at the time that it is compounded, so that in case of renewal the patient will receive exactly what he did originally.

Fig. 52.



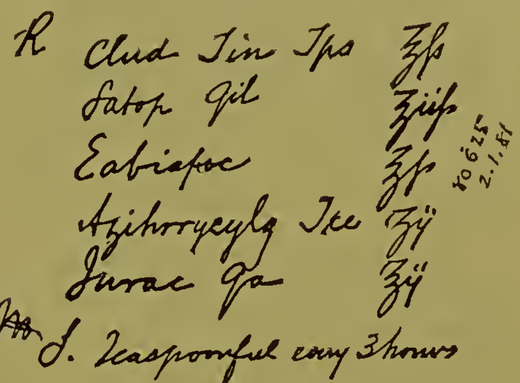
Badly-written Prescription.

In Fig. 52 is seen an illustration of one having several common faults. The use of antiquated terms is sometimes excusable, particularly when the intention is to prevent the patient from translating the ingredients. Thus, "Tinct. thebaici" is a name sometimes used instead of "Tinct. opii." Indistinctness, hurry, evidences of improper abbreviation are the principal faults, however. The prescriber wishes two fluidounces of syrup of wild cherry, half a fluidrachm of diluted hydrochloric acid or diluted hydrocyanic acid (the dispenser will have to guess at this, refuse the prescription, or see the doctor; it happened that diluted

hydrocyanic acid was wanted here, as it was for a cough mixture), one fluidounce of syrup of squills, and one fluidrachm of tincture of opium.

Fig. 53 shows what is termed a travestied prescription: it has been contrived so that the uninitiated might not be able to compound it. A physician writing such a one would tell the patient to take it to a certain druggist; of course he had previously arranged with the druggist the terms and the secret. No difficulty is experienced in compounding it if the names of the ingredients are spelled backward. The writing of such a prescription is inexcusable; no reputable physician would ever be guilty of issuing it, for even if it is not intended to get from the patient an additional fee (but merely written to prevent the patient from reading it), it bears a most suspicious "ear-mark."

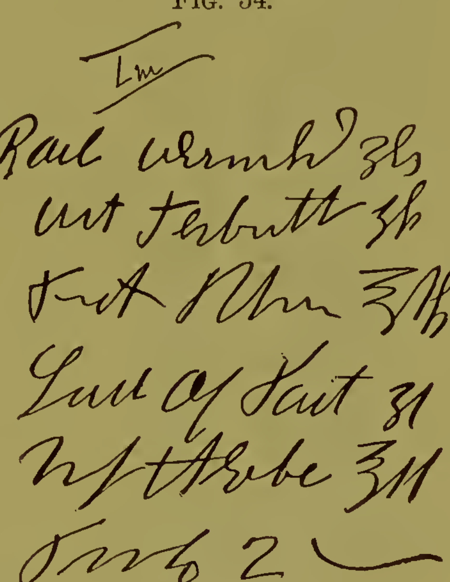
Fig. 53.



Travestied Prescription.

Fortunately for the pharmacists of Philadelphia, no more prescriptions quite like that shown in Fig. 54 are produced at present. The physician who wrote it had a very large practice, but seemed entirely to ignore all standards and rules in writing prescriptions. Fig. 54 is by no means the worst specimen in the author's collection, but a fair idea of the prescriber's style may be gleaned from it. He intended half a fluidrachm of oil of wormseed, half a fluidrachm of oil of turpentine, half a fluidounce of tincture of rhubarb, one drachm of "salt of tartar" (potassium carbonate), two fluidounces of mucilage of acacia (mu. arabe). The hieroglyphics at the bottom mean "A tea-spoonful every 2 hours." It will be noticed that Latin and English synonyms are hopelessly confused, and obsolete terms, faulty abbreviations, misspelled words, and nearly all of the sins on the calendar, have been committed.

Fig. 54.



Illegible Prescription.

Fig. 55 represents a dangerous abbreviation. It will be seen that it is an addition to a prescription, and, although the physician who wrote the prescription is usually a careful prescriber, there is ambiguity

about the fluid extract that he wishes to add to "29468." Is it fluid extract of jalap or fluid extract of jaborandi that is to be added? It proved to be jaborandi, and it was necessary to return the prescription to its author before the point could be settled.

Fig. 55.

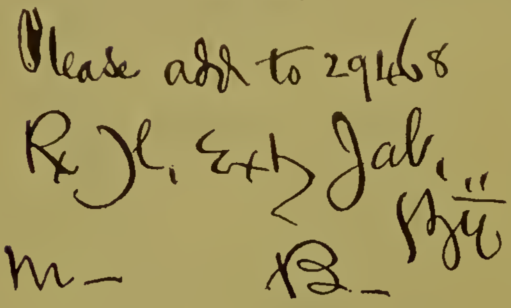


Fig. 56 is not shown as a specimen of bad penmanship or as an example of illiteracy, for the characters are fairly well formed, the terminology is above the average, and no ambiguity is noticed about the ingredients, but the number of the latter is startling: polypharmacy of a most pronounced type is here discovered. The physician who wrote it is a firm believer in compound prescriptions, and the author has in his collection two more prescriptions written by the same prescriber, each containing as many ingredients as seen in Fig. 56. Of course there can be no attempt made to indicate the therapeutic action of such a mixture.

Fig. 56.

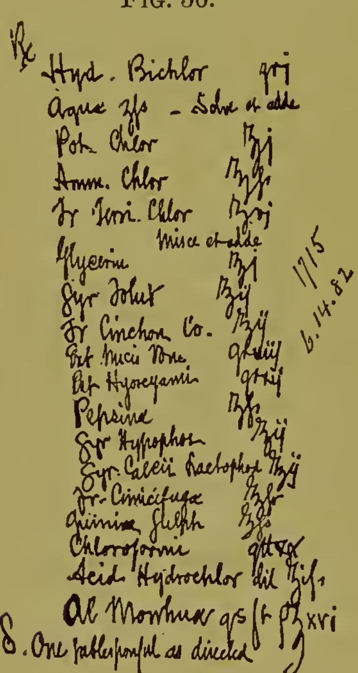
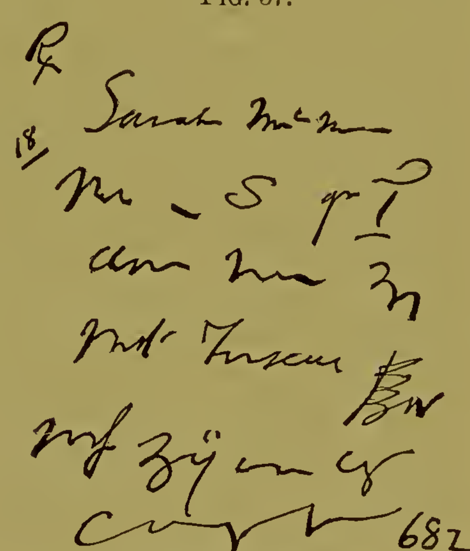


Fig. 57.



Illegible Prescription.

Fig. 57 illustrates an "out-patient" prescription written at a clinic by a physician in a hurry. It fortunately fell into the hands of a skilful and conscientious pharmacist (since deceased), who had been in the habit of reading such scrawls, and he had no difficulty in translating it in this way: "For Sarah McM——. Sulphate of morphine, one grain; ammonium muriate, one drachm; brown mixture, four fluidounces. Take two tea-spoonfuls in water for a cough."

ELECTRO-THERAPEUTICS.

By A. D. ROCKWELL, A. M., M. D.

The General Therapeutical Action of Electricity.

The use of electricity in medicine has become so thoroughly popularized that it is the exception to find a practitioner without some form of electrical appliance, and yet there seems to be in general a very indefinite appreciation of the effects of the passage of the current through living tissue, upon which are based the rationale of every electro-therapeutical result. The activity that prevails in this fascinating field of research is too frequently an activity without insight—an activity guided by no true appreciation of the laws which govern and the principles which underlie the subject. In the twenty years that have elapsed since the writer, in conjunction with the late Dr. George M. Beard, enunciated those ideas in regard to the general therapeutical action of electricity which gave the first efficient impulse to electro-medical and electro-surgical investigation in this country, the literature of the subject has accumulated beyond measure, and yet so little correct understanding is there of its physics that it is necessary to emphasize the statement again and again that electricity is not a simple, single manifestation of natural force, but is a generic term including complex phenomena and a wide variety of manifestations.

To understand its physical and physiological laws is to appreciate the fact that it is a many-edged weapon.

Is it a stimulant? Undoubtedly it is a stimulant of the most powerful character, and an ugly irritant as well when this side of its nature is sought after. Is it a sedative? As a sedative it is in some cases unequalled, and can generally be relied upon to soothe in greater or less degree a functional hyperæsthetic condition of the nervous system. Whether the word "tonic" should be dismissed from the vocabulary of medicine, as some have asserted, calls, it seems to me, for very little serious discussion. The derivation of the term from the Greek *τείνω*, "I stretch," and from still another word, *τονθω*, "I brace or give vigor," is sufficiently suggestive. We speak of toning a violin, so that its strings give forth a clearer and better sound. We do this by making them more tense. By this figurative allusion our treatises on materia medica and therapeutics describe tonic medicines

as those which gradually produce the requisite degree of tension of the nervous system and of the living fibre generally, and which enable it fitly to respond to all of its natural and appropriate stimuli. "The idea of tension is inseparably connected with all our notions of vital force, because the most common, if not the only, conception we possess of organic power is derived from our experience of the phenomena of muscular force, which is always displayed in connection with the tension of muscular fibre."

Admitting, then, the recognized significance of the word "tonic," and that remedies for improving the tone of the system still hold an important position in the classification of the materia medica, in my judgment electricity must be classed as a tonic of a very high order. It possesses varied influences of this kind, according to the kind of current used and the method of its application. To produce that tension of the nervous system and of the muscular fibre generally, so as to enable them to respond to their natural stimuli, the mechanical effects of the faradic current seem especially adapted. It is a current of alternation, of to-and-fro motion, of constant closing and breaking. Unlike the galvanic current, it possesses no chemical action to be feared, and no powerful reflex effects need render us unduly cautious in its use. In the passage through the body of a current interrupted with the requisite degree of rapidity it need produce no appreciable muscular contractions, but yet it gives passive exercise to all the deeper-lying as well as superficial tissues. The numerous branch currents going to and fro act as so many shuttlecocks, keeping every atom in incessant disturbance.

Aside from these purely mechanical effects, the experience of every electro-therapeutist must teach him that even the induced or faradic current exerts some other and more subtile influence upon the nerves themselves, for by no purely mechanical effect can we account for the numerous phenomena that follow its use in diseased conditions.

While these mechanical effects of electricity are constantly observed after simple local applications, yet he who uses this form of electricity in local pathological conditions only, and exclusively for its local effects, will fall far short of eliciting its full therapeutic power. It is this appreciation of the broad therapeutic action of electricity, and a knowledge of the details of the general methods of application necessary for its production, that have aided in the success of so many charlatans. They have accomplished results along certain lines far more satisfactory than those of the scientific physician, who has restricted his excursions in electro-therapy to purely localized methods of application.

Electricity, then, after the method of general faradization may be said to be indicated wherever a constitutional tonic influence is called for. This law renders the remedy as valuable to the general practi-

tioner as to the specialist. For the tedious period of convalescence that often follows typhoid and typho-malarial fevers there is no remedy that is comparable to it, and in a large number of conditions of depressed vitality, electricity, in some one of its forms and by some one of its methods of application, will prove of more or less service. It gives passive exercise to the muscles, it promotes and renders more natural the processes of excretion and secretion; in a word, it imparts tone and strength to both nerve and muscle. With these general principles before us we cease to wonder that electricity is used and recommended for such a great variety of diseases, many of them of an apparently opposite character, and we see the injustice of that criticism which condemns electricity because it is claimed to be of service in so many different conditions. When the therapeutic efficiency of electricity is denied, the inevitable conclusion at which those must arrive who have time and again witnessed evidences of its power is, that he who thus fails in his results is deficient in his experience, is not sufficiently persistent, or has somehow failed in the technique of his applications.

Some of the results in electro-therapeutics are due in a measure—although not in great measure, I apprehend—to physical effects. The heat excited in the tissues by the passage of either form of current is undoubtedly small, but, judging from analogy as well as facts, there can be little question but that an appreciable degree of heat is excited. All conductors of electricity become heated more or less according to the degree of their resistance, and as the body offers great resistance a certain proportion of the electric force must be converted into heat. It is, at all events, a demonstrated fact that cold extremities are sensibly warmed by faradization or galvanization, even when but few muscular contractions are produced.

Electricity possesses well-known physical effects on metals. Platinum wires are contracted by the passage of electric currents through them, and copper wires that are freely used for conductors become brittle, and it is said that the copper wires that conduct faradic currents break more speedily and more frequently than those which conduct galvanic currents. These physical facts are very suggestive of what may be facts in physiology and pathology sufficient to account for some of the therapeutic effects of electrization that as yet have hardly emerged from the realm of empiricism. These possible physical and physiological changes apply especially to the after or secondary effects of electrical treatment—effects that are noticed, not while the applications are being made or during the course of the treatment, but weeks and months after the treatment has been discontinued.

The chemical or electrolytic influences that are associated with electrical action are practically confined to that form of dynamic electricity that is termed galvanism. Its visible effects occur when needles or

pointed electrodes of metal are used, and its especial utility is in the department of electro-surgery, although it is undoubtedly true that some electrolytic action occurs in all ordinary applications of galvanism to the body whatever form of electrode is used, and is probably a factor of more or less efficiency in making up the sum of electro-therapeutical effects.

A distinction has been made, and justly, between electrolysis and galvano-chemical cauterization. The one is a disintegration and separation of the constituent elements of organized structure. The other produces its effects by means of the acids and alkalies that are liberated at either pole by electrolytic action. It is the chemical galvano-cauterization, and not the electrolysis, that accomplishes most of the good results that follow intra-uterine applications in cases of endometritis, and yet that the beneficial effects are not due solely to the acids and alkalies is evident from the fact that when ordinary acids and alkalies are applied to the body, eschars of the same degree and kind are not obtained. The current penetrates and pervades the tissues, and induces various changes beyond and beneath the eschar which continue long after the current ceases to flow.

In its influence over nutrition, however, the physiological effects of electricity are perhaps the most important. Mechanical, physical, and chemical effects must indeed combine to make up physiological effects. The former are observed on dead as well as living, on inorganic as well as organic, substances; the latter are peculiar to the living body only. Physiological effects are those which take place by virtue of the vital properties of the body, and cease when life ceases. The action of either current modifies physiological function in various ways.

First. It may increase it. This action of the galvanic current is so well known as hardly to need mention. The readiness with which the secretion of the salivary gland can be increased is readily demonstrated. Mucous secretions are very quickly increased by the action of either current, and the effects of electrization are being utilized more and more in diseases characterized by a suppression of the normal mucous secretions. Especially in the so-called dry catarrh is the treatment efficacious, as has been shown in many cases. The effect of electricity on the biliary secretion, on the gastric juice, and on the intestinal fluid, is probably stimulating, but is less easy of mathematical demonstration. Certainly, these fluids ought to be secreted in greater abundance under the influence of the current, and the results of treatment in pathological cases give this probability something of the force of certainty. My own experience is that the appetite is sharpened, digestion quickened, and constipation relieved both by local and general electrical treatment—so decidedly in many cases as to make it pretty evident that the gastric and intestinal glands are made to secrete more liberally by the

action of the current upon the nerves that supply these organs than on the tissues of the organs themselves. These results, that have been familiar to me for years, have recently been confirmed by Ziemssen in a very interesting manner by experiments on animals. He found that either form of current would increase the secretion of the various glands.

The subjective effects of the electric treatment act the same way in the bowel as in the stomach, by invigorating and improving the appetite. In the bowel it diminishes or removes the painful tenderness in the lower part of the body, as well as the feeling of movement or heat that is frequently experienced. The objective effects of the treatment Ziemssen conjectures to be that the stimulation of the motor nerve excites the intestinal ganglia, and thereby increases the flow of secretion from the intestinal glands, as well as induces a flow of the pancreatic and biliary secretion.

Among those affections of the bowels in which electricity is quite certain to exercise a beneficial influence are defective innervation, atrophy of the muscles of the bowels, digestive atony, and that large class of diseases comprehended under the name of hypochondriacal and neurasthenic.

Second. Electricity may not only diminish, but it may arrest, the physiological activity of the organs of secretion and excretion.

When, as in polyuria, the general application of the current is often followed by a marked diminution in the flow of urine, it is a desirable therapeutic effect, but the effect to which I allude is far from desirable. It comes from the use of currents so strong as to paralyze glandular function. On the lacteal secretion it acts with decided though varying power in increasing it, or in restoring it after it has been temporarily suppressed; but in two cases I have known this secretion to be promptly suppressed by the injudicious use of currents of high tension. On tne circulation the influence of electricity is a complex study, since it comprehends its action on the heart and on the unstriped muscular fibres of the arteries, as well as upon the central and peripheral nervous system.

Certainly, very sensible modifications of the circulation may be observed in any strong and prolonged application of either current, and generally on the side of an increase of the flow of blood and some elevation of temperature, with dilatation of the veins.

On the absorbents the action of electricity has been found to be of practical value in relieving many hypertrophies, effusions, and morbid growths. To follow out the rationale of its operation in producing these effects would be a difficult and tedious task, and it can only be said here that the effects of electricity on the excretory processes of the body, its direct chemical action, and its influence over the circulation

in the arteries, veins, and capillaries by its power to increase the quantity and quality of innervation received by them, must constitute most important factors in influencing the process of absorption.

The Dosage of Electricity.

The more thoroughly one studies electro-therapeutics in all its relations, medical and surgical, the clearer it becomes that the real scientific basis for the use of electricity in medicine and surgery is found in electro-physics more than in electro-physiology.

The rationale, therefore, of the various methods of electrization, of galvano-cauterization, and the important department of electrolysis can be satisfactorily understood by those only who have grasped the elementary principles of electro-physics—the laws of resistance and conductibility, and, above all, the law of Ohm. Those who have been once well grounded in these laws of electro-physics find that the various special problems that arise, whether of a theoretical or practical character, very quickly resolve themselves.

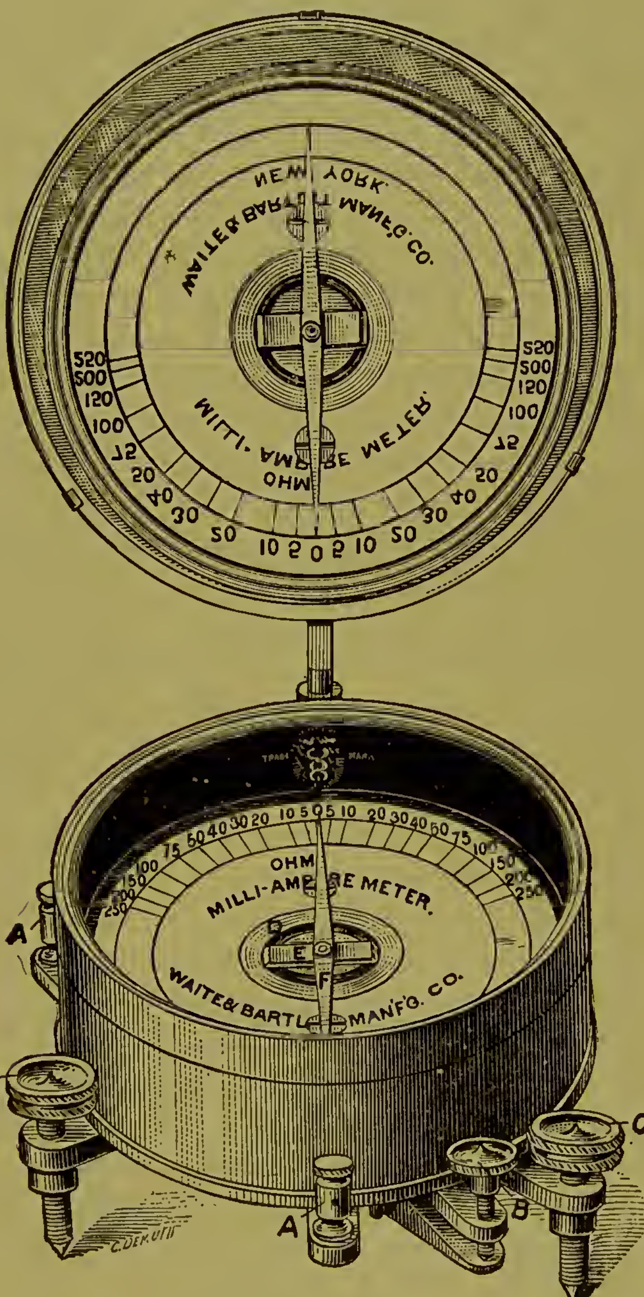
I do not propose here, however, to discuss the complicated subject of electro-physics, but to offer a few practical suggestions in regard to the important topic of electric dosage.

In some conditions and with some individuals the difference in result between a very gentle and short application and a very strong and protracted one is nothing more nor less than the difference between agreeable success and painful failure, while in other conditions and with other individuals the difference between success and failure is measured by the difference between strong and short applications and mild and protracted ones.

There are persons who must be treated not only mildly, but at long intervals; and there are persons, with perhaps the same maladies, that can bear with advantage powerful and frequent applications: to distinguish between these classes, and the various gradations that lie between the extremes of tolerance and of susceptibility, is the first duty, and oftentimes the hardest study, of him who makes much use of electricity in medicine. To state in definite terms the solution of the problem of electric dosage as it relates to these various classes and gradations is a task that I by no means propose to undertake. The ability to measure with the utmost nicety the strength of the current does not solve the problem. Such precision may be of the utmost value in the continued treatment of any given case of neuralgia, for example; but the strength there used may in no way answer for the next case, and therefore recorded statements of the number of milliampères used, in different forms of nervous disease especially, are by no means as valuable as one might be led to believe. A clear appreciation of the fact that the human system reacts to no drug with such

varying susceptibility as to electricity is one of the first and most important lessons to be learned. When we come, however, to the department of electro-surgery as represented by electrolytic action, the case is widely different. To produce certain local effects requires a certain definite expenditure of force, and the question of idiosyncrasy

FIG. 58.



Milliampèremeter.

cannot be so much considered, although even here it is not to be altogether ignored.

The "dead-beat" milliampèremeter (Fig. 58) is a great improvement on the old form of galvanometer for measuring the strength of the galvanic current. Many of the meters even now in use register

but forty or fifty milliampères, and oscillate so persistently as greatly to inconvenience the operator.

This instrument of precision by means of two short coils will accurately measure as high as five hundred or as low as one-tenth of a milliampère. The dead beat or damping effect is obtained by suspending the needle in a cylindrical block of copper three times the diameter of the needle. The current in the copper, induced by the swinging of the powerfully magnetized needle, causes the number of its oscillations to be reduced to three or four, making it possible to take a reading instantly. In some meters these oscillations amount to thirty or forty. The milliampèremeter has been used in therapeutics but a comparatively short time, although for many years nervous as well as other diseases had been treated by electricity with different degrees of success, according to the individual experience and skill employed in its use. Personally, although acknowledging the great utility of accurately measuring the strength of the current, I cannot claim greater success in the treatment of most nervous diseases, now that the milliampèremeter is employed with every application, than formerly when it was unknown; and this experience is, I fancy, common to all those who have through years of work become practically familiar with the routine of electro-therapeutical treatment.

And yet it is an immense convenience. It relieves the mind of all anxiety in regard to many minor details, and he who has once tested it will never willingly be without it. For the tyro, however, it is, I am sure, a necessity. Without it he will find himself working entirely in the dark, and a beginner should no more think of attempting serious work without his indicator of current-strength than he should administer drugs without his apothecary's measure.

Another appliance convenient to have, but not always essential, is the rheostat, the utility of which I will briefly illustrate. To-day, for example, the observer notices that the current from a given number of cells is painfully felt by the patient, while to-morrow the same strength, applied to the same patient, may be felt but slightly. If no milliampèremeter is used the mystery seems very great, and I know not how many times I have been asked for an explanation. If, however, the current is measured, the mystery is solved, for it is observed that when pain follows the application a greater number of milliampères is registered than when no pain is produced.

All this is explained by the fact that the skin varies very much on different portions of the body and in different physical conditions as to its conductibility. Now, if on one day, in an application to a patient of a current from thirty cells, the meter registers thirty milliampères, and on the next the same number of cells, with the electrodes applied on the same portions of the body, cause the meter to indicate but

twenty, we know that the patient is offering a far greater resistance to the current on the second day than on the first. It is not essential for practical purposes that we know just what that resistance is, but it is desirable and interesting to know, and the rheostat supplies this knowledge with absolute exactness. In order to find out the resistance when the registration is thirty, we substitute a rheostat for the body of the patient, and introduce a number of ohms in the circuit suffieient to hold the needle at thirty. If the number of ohms found necessary is three thousand, then three thousand is exactly the resistance offered by the body of the patient on the first day. To find out the resistance when the meter registers but twenty the same process is repeated, and if the number of ohms registered is five thousand, we know that five thousand ohms is the amount of resistance offered.

The utility of the rheostat in therapeutics is more especially in the direetion of enabling us to increase or decrease the eurrent gradually and without shock. After intercalating a resistance of one thousand or more ohms, we bring into action the number of eells that will probably be required. By gradually reducing the resistance in the rheostat the milliampèremeter soon marks the degree of quantity required. To deerease the eurrent the resistance in the rheostat is as gradually inereased until the needle points to 0, an indication that the resistance equals the strength of the current. The Germans taught the use of ridiculously weak eurrents, and, influenced by these teachings and by a natural respect for an agent so subtile, the average degree of strength employed when I began the use of galvanism was in many cases entirely inadequate. In its application to the head ten or twelve eells were, as a rule, considered quite sufficient. Beneficial results were often seen to follow such mild treatment, it is true, and it was seldom that greater strength was attempted; but that the dose of electricity thus obtained was exceedingly slight, and far more inefficient than was then supposed, can be readily demonstrated. The cephalic electrode was a broad, thick sponge, while the other electrode, applied generally to the pit of the stomach, was of sponge also, but much smaller. The resistance thus offered is necessarily very great, and if the milliampèremeter is used, it will be found that the actual quantity of eleetricity passing through the body of the patient hardly exceeds six or seven milliampères. Now, to use a eurrent of only this strength in applications to the nerve-eentres is, as a rule, little more than child's play.

Sometimes benefit may undoubtedly accrue from these very mild applications, but I have for so long a time observed the effects of a bolder line of treatment that I have no hesitancy in advocating it in preference to former methods. In place of a current of five or six milliampères substitute one of twenty, and the superiority of the results thus obtained will soon beeome manifest. But if, by the method in

common use, twelve ordinary cells in the treatment of the head deflects the needle but about five degrees, it would take some forty-eight cells to give a strength of twenty milliampères; and few physicians have any such number at command.

For this purpose the electrodes should be as large as possible; that is, broad, flat, or curved, according to the part of the body to which they are applied, but with little bulk. With electrodes such as these, and a series of sixteen Leclanché cells, a current of twenty milliampères can readily be obtained in applications from the head to the solar plexus. Thirty-two cells would therefore give forty milliampères, an intensity of current seldom necessary to exceed, or even equal, in central galvanization. In making these strong applications to the brain there is an element of danger which cannot be emphasized too strongly—namely, the possibility, and indeed the probability, considering the utterly haphazard way in which electricity is too frequently used, of the current becoming suddenly broken. Even with very weak currents applied to sensitive nerves or to the head interruptions are, as a rule, undesirable, and when strong, as indicated by a deflection of the needle of fifteen or more, they may painfully aggravate the very symptoms that you are endeavoring to allay. As an illustration of this most important fact, I will refer to two out of a number of cases upon which this statement is based.

The first was a case of epilepsy, one which had been helped up to a certain point only by the persistent use of the bromides, but which had very greatly improved, and finally recovered, when the treatment was supplemented by galvanization of the brain. The attacks had been growing far less frequent, and at this time some three months had elapsed since the last. The patient was feeling exceedingly well, and this in itself was by her regarded as a guarantee of exemption, for invariably before a paroxysm she was accustomed to feel far from well. With one pole at the epigastrium and the other on the head I was gradually increasing the current until it probably indicated some fifteen or twenty milliampères. In some way the connection was suddenly broken, and, with the characteristic cry, the patient fell over in an epileptic fit, and one, as I afterward learned, of far greater severity than usual.

The other was a severe case of chorea of long standing. The patient was slowly but surely recovering, and had so far regained command of his lower limbs that he could walk with but slight evidences of any lack of co-ordinating power, and could use his knife and fork with ordinary readiness. About this time he inadvertently received a shock through the head of a current-strength of some twenty milliampères. Results of a most unpleasant character followed. The choreic movements of the arms and legs returned in a marked degree, so that he

walked with uncertain steps and could no longer feed himself. These aggravated symptoms continued for about ten days, and then began gradually to subside.

I would by no means be understood to say that a galvanic shock, even though severe, will always cause marked increase of symptoms that are subsiding under the use of an uninterrupted stable current. Such shocks are many times given without any apparent evil result. They should, nevertheless, be guarded against in every possible way, as their tendency is undoubtedly harmful.

One of the diseases to which I will refer in giving more definitely my own experience in regard to electric dosage is epilepsy, a condition in which electricity is far from being generally recognized as capable of any special service. As far back as 1878, I wrote upon the subject, and recently gave, before the New York Academy of Medicine, the results of my observations in twenty-eight cases. All of these twenty-eight cases of epilepsy were treated without the aid of accurate current-measurement, since the milliampèremeter is of comparatively recent introduction. It is, however, possible for me to give approximately the strength of current used in most of these cases. The range was between ten and thirty milliampères. I have found no patient suffering from epilepsy who could not endure, without ill effects, a current of ten milliampères, provided the cephalic electrode covered a surface sufficiently large and was accurately adjusted, while most of them bore without discomfort a much stronger current. I should regard more than thirty milliampères seldom if ever desirable. The strength that I have found most generally acceptable and of service to my patients has been from fifteen to twenty-five milliampères.

In chorea substantially the same rule prevails in regard to strength of application, or would prevail if the average age of choreic patients was not much less than that of epileptics. The strength of current applied to the head in any case of chorea under twelve years of age should rarely exceed twenty milliampères, and generally should be about twelve.

We cannot approximate the relative dose of electricity for different ages as accurately as we can that of drugs. The following observations, however, will be found to be uniformly correct. The very young bear proportionately very much stronger currents than adults. A child of three years, who should, according to rule, tolerate only about one-fifth the adult dose of any powerful drug, will easily bear one-third, and sometimes one-half, the adult dose of electricity. Old people bear stronger currents than those in middle life; it is, indeed, quite astonishing to observe the very marked insusceptibility of some very old people to electricity, due in some measure perhaps to blunted sensibility, as well as to a loss of conductibility of the tissues, and especially of the skin.

It will not answer, however, to presume too much in the application of electricity to the old on account of this apparent insusceptibility, as it is not uncommon to meet with persons advanced in years who, while they may feel the application of a certain strength of current but little at the time, are yet exceedingly susceptible to its secondary effects.

Another disease for the relief of which the galvanic current is but indifferently appreciated is exophthalmic goitre. Without it, indeed, it is often impossible to obtain results at all satisfactory, but with it marked amelioration of the symptoms almost invariably follows, and not infrequently complete or approximate recovery in cases that have responded unsatisfactorily to internal methods of treatment alone. The strength of current indicated varies according to the position of the poles. An important point for local application is the auriculo-maxillary fossa, immediately below the lobe of the ear, where but a comparatively small electrode can be used. A strong current would produce both pain and vertigo, and from five to seven milliampères is about all that will be well borne with an electrode in this position. As we gradually move the pole down along the inner border of the sterno-cleido-mastoid muscle the strength can be increased very materially, and with one broad electrode at the back of the neck, near the sixth cervical vertebra, and the other on the enlarged gland, currents of twenty and thirty milliampères can be profitably utilized. The variation of current-strength in the treatment of neuralgia and pain in general is as wide as the symptoms are varied in character and seat, and more perhaps than in other diseases is it necessary to discriminate carefully in the selection of the proper current. True neuralgia (pain directly along and confined alone to the course of a nerve) calls almost invariably for the galvanic current, while the so-called pseudo-neuralgias, which are simply forms of pain occupying certain areas and running seemingly in the direction of certain nerves, yield most readily to faradism. From five to ten milliampères are, as a rule, amply sufficient for the relief of neuralgia about the face and head, while in sciatica, it is often necessary to use as much as forty or fifty, or even more. The efficacy of very strong currents in the treatment of sciatica should be more generally recognized. As ordinarily used, it often fails to relieve because of an insufficient current. The operator is simply self-deceived. He is using perhaps a large number of cells, freshly and properly charged, but his electrodes are of a pattern and size to offer the greatest possible resistance. Let him substitute electrodes that are broad and flexible, readily adapting their shape to every inequality of surface, and this difficulty of lack of strength will quickly disappear.

In the treatment of paralysis, whether central or peripheral, the dose of electricity is determined by so many modifying factors that it cannot be fully discussed here. The general law, that when a muscle

fails to respond to the faradic current recourse must be had to the galvanic, is now usually appreciated, but it is not so generally understood that paralyzed nerves are not to be indiscriminately stimulated by sudden shocks. Many a paralysis that might have recovered has been made permanent by such ill-directed and culpable interference.

After the degree of quantitative or qualitative change has been determined by careful interrogation of the affected muscles, it is in many cases imperative to use the continuous and not the interrupted galvanic current. Especially is this true in those cases of local paralysis in which responses utterly fail to be elicited by the faradic current, but are more readily obtained through the galvanic current than in the normal condition of nerve and muscle. In such cases mild currents of about seven milliampères, increased to twelve or fifteen as improvement increases, and applied without interruption, will succeed in lessening the irritability of muscular fibre and in restoring the lost vitality of the intra-muscular nerves—upon the integrity of which the faradic current depends for its ability to call forth muscular contractions—far more effectually than when interruptions are attempted.

In most forms of paralysis, however, much stronger currents than these can be employed. In infantile paralysis fifteen or twenty milliampères may be used, and in the spinal paralysis of adults (polio-myelitis) twenty-five or thirty are usually indicated. In both these conditions, but more especially in infantile paralysis, the same rule should be observed as in the treatment of the form of facial paralysis to which allusion has been made—for the most part continuous and not interrupted currents.

Given a case of infantile paralysis in which reaction to the faradic current is entirely lost, and only faintly appreciable to the galvanic current, it is entirely possible by sudden shocks to obliterate the little remaining vitality and render the case incurable.

In hemiplegia, again, while electricity possesses but a limited value, it is yet capable of doing decided harm. I have at this time under observation a hemiplegic patient whose arm was in such a condition of heightened irritability that contractions to both currents were called forth far more readily than in health. He fell into the hands of one who possessed greater activity than insight, and was subjected to a series of treatments by the faradic current in which the muscles of the arm were jerked about in a most merciless manner. As might have been expected, there soon supervened an entire loss of motility, together with neuralgic pains of a distressing character.

In alluding to epilepsy and chorea, I spoke of central galvanization and its dosage in those diseases. Central galvanization is also a valuable method in many neurasthenic conditions, in hysteria, and in cases of melancholia. The hair being thoroughly wet, a light wire gauze

helmet, lined with some soft conducting material, is fitted as accurately as possible to the head. To this is attached the positive pole, while the negative is applied to the pit of the stomach and a current passed, varying, according to the disease and individual idiosyncrasies, from five to thirty milliampères. It may seem an easy thing to make use of central galvanization satisfactorily, but, like most easy things, its efficient use demands knowledge, care, and some experience; all of which are within easy reach of those who desire to utilize the method. The wide area which this helmet electrode covers lessens by just so much the resistance to be overcome, and enables us to pass through the head a current of many milliampères without pain or other ill result. To this end, however, the electrode must be made to adjust itself accurately to every inequality of surface, otherwise a painful concentration of current will be felt at various points and the efficacy of the application interfered with.

Any discussion of the subject of electric dosage would be incomplete without reference to gynæcology, in which electricity has accomplished much good. Here, more than in any other department of medicine, is illustrated the great superiority of strong and comparatively short applications, over those which are weak and prolonged.

Much of the ill-success that formerly attended the treatment of diseases of women by electricity was due to the use of too feeble currents, and the same misapprehension as to its actual working power, alluded to when speaking of central galvanization, existed here. With one ordinary small and comparatively thick sponge electrode applied externally to the abdomen, and the other internally, a current from thirty-six cells will cause a registration possibly of not more than twenty-five to thirty milliampères. A current of this strength is entirely insufficient with which to treat successfully many uterine diseases that experience has shown to be amenable to electrical applications; and in order to obtain the requisite strength without resorting to the great number of cells that would ordinarily be required, electrodes of an entirely different pattern are necessary. They should be large and flat, and readily adapted to every inequality of surface.

Apostoli, whose experience has probably been greater than that of any other in the electrical treatment of the uterus and its appendages, first suggested the electrodes made of sculptor's clay, held in place by gauze and sufficiently large to cover much, and sometimes the whole, of the abdomen. The principle involved is simply this: The larger the electrode, the less the resistance, and, other things being equal, an electrode of six square inches will yield but one-half the current of one of twelve square inches. In the treatment of uterine diseases it must be remembered that the internal is the effective pole, while the external is the indifferent or dispersing electrode. Bearing in mind also

that the genital mucous membrane is remarkably insusceptible to painful impressions, while the skin is the reverse, the necessity of large flexible electrodes that can be accurately adjusted is readily appreciated.

In the treatment of indurations and enlargements of the uterus and the exudations resulting from pelvic cellulitis direct applications frequently result in complete recovery. Currents of from thirty to fifty milliampères are indicated, and should not cause the slightest pain. On the contrary, there is often instant relief afforded to an ever-present pain, as well as the more remote results as seen in the correction of painful menstruation. If the metal electrode is applied directly, without the intervention of some covering, care must be taken not to use currents sufficiently strong to produce eschars. This mishap may occur even without the knowledge of the patient, and it is therefore always safer to use a covered electrode.

I have seen this treatment, judiciously and persistently carried out, melt away, as it were, not only large pelvic deposits, but in two instances relieve a most severe and chronic sciatica that had been caused by the pressure of these pelvic deposits. In ovarian and fibroid tumors the electrolytic method is undoubtedly worthy of consideration, although in ovarian tumors the results have not as yet been sufficiently satisfactory to commend themselves strongly to authorities in the department of uterine surgery.

It is perfectly safe to use currents of from one to two hundred milliampères in the treatment of uterine fibroids. Whenever in the use of electrolysis our aim is destruction, and only destruction, I see no reason why even stronger currents might not be used. In one case of uterine fibroid at a clinic at the New York Post-Graduate Medical School, I myself used a current-strength of three hundred and fifty milliampères.

It must be remembered, however, that some of the best results of electrolysis are not measured by the degree of chemical action, and that when various external tumors, such as goitre, disappear under feeble electrolytic action, it is through a process of absorption that is set up, and not because of the destruction of tissue. In the treatment of goitre currents of forty milliampères are indicated. Absorption is hastened by the chemical changes that occur, and takes place both during and after the treatment. In most cases it is not observed at all during the operation, but goes on slowly for weeks following.

Stimulation of absorption is especially marked when electricity acts on hydrocele and small cystic tumors. For their treatment a current of thirty to forty milliampères is required. In erectile tumors, in which the object is to coagulate the blood, we use about the same strength as when treating cystic tumors.

Current Differentiation.

A frequent question, and one somewhat difficult to answer without qualification, is, Which of the two forms of dynamic electricity is the more useful in practice? As generally used, undoubtedly the galvanic current has a wider range of usefulness in medicine and surgery than the faradic. In other words, and generally speaking, diseases and symptoms of disease that are circumscribed and local indicate, as a rule, the galvanic rather than the faradic current. If, however, a broader view of the remedial action of electricity be taken, and its powerful tonic influence recognized when administered by the methods demanded for the production of such effects, it is quite another matter, and the faradic current assumes an importance which any form of local use fails to give.

It may be said, therefore, that if the general practitioner will make himself acquainted with general faradization, and take the time and trouble to apply it with the thoroughness that its successful use demands, he will accomplish quite as much with the faradic as with the galvanic current, although in quite a different class of cases.

In briefly discussing the relative efficiency of the two forms of dynamic electricity in medicine, I will first consider the measure of their agreement and disagreement in their physical and physiological activities, and, second, state some of the differential indications for the use of the currents in treatment. The first of these considerations is necessary to an intelligent appreciation of the second, for the more thoroughly one studies electro-therapeutics in all its relations the clearer it becomes that the real scientific basis for the use of electricity in medicine and surgery is found in its physics and physiology, especially the former.

Now, electricity, however generated, whether through chemical action, through friction, or through induction, and however modified by its passage through any resisting media, is electricity still. Both currents, the faradic and galvanic, are obedient to the law of Ohm, and while there is a wide difference in the degree of their physical and physiological properties, these are in kind essentially the same.

Both currents are capable of producing electrolytic effects, and this can be readily demonstrated with the current from the first induction coil of an ordinary faradic apparatus. The action of this current on a solution of salt and water is exactly the same in kind as the action of the galvanic current. Both currents also evolve light and heat, and the bright deflagrating spark caused by the electricity as modified by the thick, short coil of wire is even more brilliant and disintegrates metal more readily than the current direct from many cells. Both currents will electro-plate, and by some of the giant magneto-electric apparatus this is done on an enormous scale.

The milliampèremeter is an instrument of precision that is now indispensable in the use of the galvanic current, and yet by connecting the posts with the poles of a faradic apparatus an appreciable deflection of the needle is observed, and this deflection very naturally becomes still more marked if the current from the primary coil is thus utilized. This power of the faradic current to cause, like that of the galvanic, electrolysis and deflection of the needle is so inferior in degree to the power of the galvanic current that we cannot utilize the former in electro-surgery, nor is the galvanometer available to measure its strength. Thus it can be readily demonstrated that, however differently generated or however modified by the medium through which they pass, the various forms of electricity are only different manifestations of one great force.

Physiologically, we find this agreement between the effects of the two currents quite as close as when physically considered. The phenomenon of electrotonos, to be sure, has been demonstrated only as it relates to galvanism, but it is the common experience that even with the faradic current the positive pole is the more calming, and the negative the more stimulating.

Applied directly to the brain or spinal cord, both currents excite muscular contractions, and about in the same degree, similar results having been obtained in the well-known experiments of Fritsch and Hitzig, who used galvanism alone, and of Ferrier, who used faradism. The result of direct electrization of the sympathetic nerve is a change in the calibre of the cerebral blood-vessels, and the only difference in the action of the two currents is the greater rapidity with which effects follow the application of the galvanic current. The nerves of respiration are affected in about equal degree by both currents, and even in their action on the nerves of special sense the close relationship of the two is unmistakably evident.

You cannot in a healthy person—or, as a rule, even in one that is sick—so excite the optic or gustatory nerve by the faradic current as to call into activity the vital function of these nerves. There are, however, some exceptions to this, as exemplified in certain hysterical and neurasthenic cases in which there exists an unusual susceptibility of the nervous system. In such cases the faradic current has occasioned not only the appearance of flashes before the eyes and a metallic taste, but the auditory nerve itself has been known to respond to its influence. These examples are quite sufficient to show that the action of the two currents is so similar as to prove them substantially the same in kind, but at the same time so widely do they differ in the degree of their physical and physiological power that it is often practically equivalent to a difference in kind, rendering one current inferior or superior to the

other in a most remarkable degree, according to the special indications in individual cases.

In view, therefore, of the superiority of the galvanic to the faradic current as relates to its physical and physiological energies, it seems hardly necessary to say that the former is to be used when we wish to act with special electrotonic and electrolytic power on the brain, spinal cord, the sympathetic, or any part of the central or peripheral nervous system. We use it when we wish to produce contractions in paralyzed muscles that refuse to respond to the faradic current, and in electro-surgery when we desire to produce, through electrolysis and cauterization, the destruction or absorption of morbid products and the coagulation of blood. We use the faradic current to act mildly (probably for the most part through reflex action) on the brain, spinal cord, sympathetic, or any part of the central or peripheral nervous system. We use it to excite muscular contractions whenever the muscles are not so much diseased as to be unable to respond to it, and to produce those strong mechanical effects through which, in great measure, are obtained the remarkable constitutional tonic influences now everywhere so well recognized.

In order to illustrate a point in current differentiation which I regard as of considerable value I may be allowed to instance two cases. The point to which I refer relates to the effects of pressure as indicating the kind of electricity most likely to prove of service in the different forms of pain for which relief is sought. Without attempting to discuss the relation of pain to pathological states or its different forms and locations, I call attention to the well-attested fact that of all innoxious remedies electricity is the most powerful agent in nature for the relief of pain. Not that it never fails, for this it does often enough, but its failures would be far less frequent and its reputation along this line more firmly established if the differential indications for its use were more carefully considered.

It is a common observation that in many forms of pain and so-called neuralgias firm and equal pressure over the affected parts causes no discomfort whatever, and frequently affords marked temporary relief. In other cases the parts are sensitive to all external impressions, and pressure or rubbing decidedly aggravates the existing pain. True neuralgia is undoubtedly, as a rule, represented by the last class of cases, while the former class, in which pressure relieves and in which pain occupies certain areas and runs seemingly in the direction of certain nerves, must be classed among the hysterical and pseudo forms of neuralgia.

In true neuralgia the pain invariably can be definitely mapped out along the line of certain nerve-trunks, and in these cases the galvanic current is almost without exception indicated, and not the faradic. In

the hysterical and false forms of neuralgia, however, the indications for the faradic current are almost as invariable as they are for the use of the galvanic in true neuralgia. I say almost, for we do occasionally find cases of the pseudo and hysterical forms of neuralgia in which the affected parts are not only sensitive to pressure, but also unusually sensitive to the effects of electricity, affording additional proof of the general correctness of the statement that painful parts that are sensitive to pressure indicate the galvanic, and those that are insensitive to pressure call for the faradic current.

Cases of widely diffused and superficial neuralgic pains, with sensitiveness to pressure, as well as those belonging to the true type of neuralgias, are best treated by the galvanic current alone. This practical point in electro-therapeutics is well illustrated by the two following cases, which were treated at the clinic of the New York Post-Graduate Medical School, the histories of which I transcribe with my remarks made to the class. In the case of the first patient there was a statement simply of pain in the head, which began six years before:

"Pain was diffused quite widely over the vertex, but seldom affected the forehead or occipital region, and up to the present time he has been able to find no remedy that has afforded more than temporary relief. His general health is fair, and careful examination has failed to detect anything specially abnormal in the urine. In the morning he is quite comfortable, but about 2 P. M. the pain begins, and continues until he goes to bed, when he is benefited by sleep, as he is also by outdoor exercise, and frequently also by a hearty meal and cold-water applications. When entirely free from pain the part is not more than ordinarily tender, but while suffering the slightest touch is disagreeable, and any form of pressure or rubbing becomes decidedly painful.

"Here, then, is a case where, if electricity is to be used at all, we must decide between its different manifestations. I have not the slightest doubt but that the faradic current would have altogether failed to relieve him, and it might have aggravated his symptoms. The galvanic current, on the contrary, as he will be glad to assure you, has during the few weeks that the applications have been made resulted in a decided mitigation of his symptoms, and we confidently expect complete recovery. I will now treat him by the method of central galvanization. I begin with five milliampères of current, and gradually increase it until twenty are reached—a strength seldom necessary to exceed in these cases. He says that the metallic taste is strongly marked and the saliva flows freely, but there is no pain, because, as you observe, my electrodes are large and soft and applied firmly and with equal pressure. By decreasing the current as gradually and carefully as it was increased all interruptions are avoided, and the treatment concluded without disagreeable flashes of light or shock.

"The second case is a good illustration of the other side of the question. The pains first began to trouble the patient three years ago,

and so severe were they that he gradually formed the morphine habit, taking finally as much as eight and ten grains a day. From this habit, however, he at last succeeded in breaking away, and since August last has not indulged in it. The pain is located in the forehead and temples, being at times most severe on one side, and then again on the other. It comes on two or three times a week, and, unlike the first case, all forms of activity aggravate it. Unlike it, also, firm pressure and rubbing afford grateful relief, and the degree of insensitiveness to electricity (faradism) is quite remarkable.

"You are perhaps aware how exceedingly sensitive the forehead, and indeed all bony prominences, are to the induced current of electricity; but in this case the strength that is applied without discomfort is many times greater than any one in this room could possibly endure.

"The faradic current is as strongly indicated here as was the galvanic in the other case, and I am glad to say that it has been followed thus far by equally good results. I use my hand in applying the faradic current to the head, because no electrode that human skill can devise can equal the hand in flexibility and power of adaptation to uneven and painful areas; and as I now apply it the current is so strong that only long practice enables me to manipulate the parts successfully."

Electricity as a Means of Diagnosis.

Injury to a motor nerve is followed by certain anatomical changes associated with altered function as well as altered electrical reactions. There is always a very definite correspondence between the two, and in the ability to determine from the electrical conditions the histological state of nerve and muscle consists, in the main, the art of electro-diagnosis.

When a motor nerve is divided the muscles which it supplies are immediately paralyzed, and, no longer being in connection with their nutritive centre, the spinal cord, both nerve and muscle undergo pathological changes. Accompanying these changes are marked deviations from the normal electrical reaction of both nerve and muscle. *Immediately* after the section of a nerve there is often a temporary increase of electrical response to both currents when applied to the nerve or the motor-point of the muscle. Subsequently, however, there is a steady decrease in the readiness with which electrical reactions take place, until finally the excitability to both currents is completely abolished. These, it should be observed, are termed *quantitative* changes.

If the applications are made directly to the muscle, and not to the nerve, we find quite a different set of phenomena. The faradic current, applied thus, acts very much as when it is applied to the nerve; not so the galvanic. When the latter is applied directly to the muscle, there is observed an immediate diminution in the readiness of response, but in a comparatively short time an increase of the electric excitability

is developed. This is a sure indication that we still have healthy muscular fibre, but fibre deprived of its nerve-influence.

Soon, however, the muscular fibre itself begins to degenerate, and the galvanic current, instead of being followed by an increased readiness of response, acts upon the muscle less and less effectually, and finally, if regeneration in the nerve-structure does not take place, the galvanic irritability to muscle becomes extinct.

Accompanying this decreasing readiness of response are other changes in the character of the contractions, termed *qualitative*, or, as they have been called by Erb, the reaction of degeneration. If regeneration of the nerve and muscle should occur, galvanic reaction is also re-established, but fails to reach its normal standard for a long time. I have seen a number of cases in which the response of muscle to galvanism remained below the normal standard long after the complete return of voluntary movements and perfect response of nerve to faradism.

A case of facial paralysis that I have recently had illustrates many of the foregoing points. A week subsequent to the attack there was found to be marked diminution of response to both currents. On the tenth day or thereabouts there began to be a progressive increase of response to the galvanic current, but no abnormal reactions indicating degeneration of muscular fibre. These phenomena, however, began to appear at a later period, associated with a gradual decrease of galvanic response, and now neither current, when applied to the nerve, produces the slightest effect, while galvanism directly to the muscle causes only feeble and delayed reactions with currents as strong as can be borne by the patient. These observations illustrate in a very interesting manner the progressive anatomical changes that take place in an injured nerve, and the relations they bear to electrical phenomena.

The diminished reactions to both currents first observed when applied to the nerve indicated that the nerve-tissue itself was structurally altered, but did not necessarily indicate muscular degeneration. There occurred, on the contrary, increase of response to galvanism applied directly to the muscle, indicating that the muscular fibres were still healthy. This increase of reaction is said to be due to the deprivation of the inhibitory action of the paralyzed nerve, as well as the altered nutrition of the muscle itself. The reactions of degeneration which finally appeared, and still exist, together with the quantitative changes or decrease of response to both currents, indicate degeneration of the muscular fibre itself, which may go on to a complete extinction of the electrical reactions. This indicates complete destruction of the muscle. As in the study of auscultation it is necessary to understand the normal action of the heart, so in the study of electro-diagnosis it is necessary to understand the order in which contractions

occur in the healthy nerve and muscle when subjected to the "make and break" of the galvanic current. Bearing in mind that in health the closing contraction is always more vigorous than the opening, whichever pole is used, and that the cathode or negative pole acts more vigorously than the anode or positive pole, it is readily appreciated that there can be but four orders of contractions elicited in health, in the following order:

1st. The cathodal closure contraction, indicated by the formula C.C.C.;

2d. The anodal closure contraction, A.C.C.;

3d. The anodal opening contraction, A.O.C.;

4th. The cathodal opening contraction, C.O.C.

When, therefore, we speak of quantitative changes occurring in the electrical response, we mean simply that this order is changed, the A.C.C. being greater than the C.C.C., or the C.O.C. exceeding the A.O.C. These changes are also referred to as the "reactions of degeneration," and invariably indicate structural disease of muscular as well as of nerve tissue, while quantitative changes indicate degeneration of nerve-tissue only. This is an important point which it is well here to emphasize, for I find there exists a very general misapprehension in regard to it.

Qualitative changes in the electrical reactions are generally, if not always, associated with marked quantitative changes, while quantitative are often entirely independent of qualitative alterations. The one (quantitative) indicates more especially disease of nerve-structure; the other (qualitative) suggests degeneration of muscular tissue.

Such diseases as progressive muscular atrophy, pseudo-hypertrophic muscular paralysis, amyotrophic lateral sclerosis, and bulbar paralysis excellently illustrate degeneration of muscle with healthy nerve. In progressive muscular atrophy, for example, the electrical reactions demonstrate a healthy nerve, but a degenerated muscle. Either current applied to the nerve calls forth normal contractions. The faradic current, applied directly to the muscle, calls forth contractions according to the amount of healthy fibre remaining. The fact that it produces contractions at all demonstrates the integrity of the nerve-fibre, while the qualitative changes that are elicited on the application of the galvanic current to the muscle indicate the extent of the muscular degeneration. Similar phenomena are observed in the other diseases that have been mentioned in connection with progressive muscular atrophy. The diseases, on the other hand, that show healthy muscle, but diseased nerve-tissue, are confined altogether to those of central origin.

These are paralysis from cerebral disease, and with few exceptions all those forms of spinal paralysis in which the gray matter of the

spinal cord is not involved. Therefore, locomotor ataxia, the various forms of multiple sclerosis without trophic changes, and spastic paralysis are seldom, if ever, associated with qualitative changes. Quantitative changes are not infrequently observed in these spinal diseases, as well as in disease from cerebral lesion, but their causation is found in a general excitability due to an irritative lesion, to an absence of inhibitory action, or to atrophy of muscle through disease, and not to actual degeneration. In some nerve-trunk diseases, and also in acute affections of the gray matter of the cord, neither current applied to the nerve calls forth reactions.

Faradism to muscle gives no response, but galvanism to muscle is followed by normal or increased response. This indicates that both the nerve-trunk and its nerve-filaments are diseased, but that the muscle itself is healthy. These phenomena are of course observed only in the very earliest stages of the diseases mentioned, and in the nature of things must as a rule escape observation. Polio-myelitis anterior, on the contrary, whether occurring in the adult or in childhood under the name of infantile paralysis, and also lead palsy, uniformly yield those quantitative and qualitative changes that indicate degeneration of both nerve and muscle.

There are, again, still other forms of paralysis from spinal disease in which the character of the reactions varies widely according to the seat of the lesion. In myelitis, for example, the electrical reactions may be absolutely normal, indicating that the disease is probably confined to the antero-lateral or posterior columns, while in other and the majority of cases there are quantitative and qualitative changes that clearly point to disease of the gray matter of the cord.

An interesting deviation from the ordinary reactions found in diseased nerve and muscle, but one not very frequently met with, I imagine, is where both currents applied to the nerve or the motor-point of the muscle fail to produce any contraction whatever, while either current applied to the muscle directly calls forth reactions even more vigorous than normal. It is perfectly plain that this phenomenon means a diseased nerve-trunk, but a healthy muscle, with healthy intramuscular nerve-branches. As these reactions have been observed only in the very earliest stages of a traumatic injury to a nerve and in rheumatic neuritis, they would necessarily in most cases escape notice.

Methods of Electrical Application.

The main methods of electrization are five in number—viz. 1st. Localized faradization; 2d. Localized galvanization; 3d. General faradization; 4th. Central galvanization; 5th. Franklinization. These are of course subject to infinite variation in the practical details of

their application; but a general description of each may prove sufficient as the foundation-stones on which to build experience.

Localized Faradization.—The art of limiting the excitation of the faradic current to certain organs and tissues is in the main due to Duchenne. He called attention to the fact that electricity could be localized under the skin if moist electrodes were firmly pressed upon the skin. He was led to this observation by the very familiar phenomena that follows the application of the dry electrode or hand to the surface of the body—viz. a crackling sound, but no sensation and no muscular contraction. This is due to the very slight conductivity of the skin. Through moisture, however, its conductivity is increased, and he observed that when wet electrodes were applied the same strength of current excited contractions immediately. This system, simple in its origin and detail as it may seem, has been refined and developed until it has grown into a permanent department of science. To be proficient in its use demands a certain amount of anatomical and physiological knowledge and manual facility; but its successful employment requires neither the dexterity nor care that is exacted by localized galvanization, general faradization, and central galvanization, nor the time and patience demanded by the last two methods. For these reasons localized faradization has been generally adopted by the mass of the profession, to the exclusion of the more advanced processes by which alone we can fully utilize the therapeutic powers of electricity. In carrying out the details of localized faradization the situation of the motor-points should be carefully studied. Ignorance of these points will involve waste of time in searching for them with electrodes in hand, and at the same time add to the annoyance of nervous patients. By placing the negative pole over the motor-point and the positive over the belly of the muscle, we obtain immediately the best possible contractions, whether for therapeutic or diagnostic purposes, with the minimum strength of current.

Localized Galvanization, especially when applied for the relief of pain, is a procedure of much greater delicacy than localized faradization. It was introduced to the profession more especially by Remak in a work *On the Methodical Electrization of Paralyzed Muscles*, by virtue of which he became the founder of a school of electro-therapeutics in Germany, as Duchenne had been in France.

The term "stabile application" is employed when both electrodes are kept in a fixed position. The term "labile application" is employed when one or both electrodes are glided over the surface, without, however, causing any interruption of current sufficient to produce appreciable muscular contractions. When we desire to induce a purely sedative influence, it is of the greatest importance that the galvanic current should not only be free from any distinct interruption,

but that every variation of current-influence, such as follows moving the pole along the skin, should be carefully avoided. At other times, however, it is desirable that our applications should be increasing, by which is meant that the current-strength is augmented with more or less rapidity without removing the electrodes. If the current is thus gradually increased, a much greater power can be borne than if it is suddenly let on in full force with the first closure of the circuit. A current which may produce unbearable pain, or, when applied near the nerve-centres, dizziness and faintness, may be borne without discomfort and with positive advantage if it is gradually increased from the minimum of current-strength.

Applications to the brain, eye, and ear especially, and to the sympathetic, spinal cord, urethra, and to all conditions of great irritation wherever seated, should always be thus gradually increased, and in the same way decreased. With the faradic current the management of these increasing and decreasing currents is very simple; but gradually to increase the galvanic current, especially if no rheostat is at hand, requires very great care.

Most galvanic batteries that are now made have an arrangement that gradually adds to the number of working elements without interrupting the current; but even with the greatest precision of manipulation breaks are apt to occur when least expected or desired, and it is far safer, therefore, to be always provided with some form of rheostat.

Labile or stabile interrupted currents are generally preferred for the galvanization of muscles, while for the galvanization of the head, spinal cord, sympathetic, nerve-tracts, and plexuses stabile continuous currents, either uniform or increasing, are, as a rule, indicated. In addition to their power to produce muscular contractions, labile or stabile interrupted currents cause more marked physical and mechanical effects, while stabile continuous currents, whether uniform or increasing, produce the stronger electrolytic and catalytic action. In applying the galvanic current to the brain it is well to remember that there is less tendency to dizziness if the negative pole is applied first and the circuit closed and opened with the positive pole. There are many special effects of localized electrization, as of general faradization and central galvanization, but the leading and general results of all the methods is improvement in nutrition.

Localized electrization of poorly-nourished and atrophied muscles develops size and increases strength; localized electrization of any organ, such as the uterus, the nutrition of which has become impaired and its size diminished, tends to develop it and to increase its functional activity. In localized electrization these results are of course of a local nature; yet, owing to the fact that absolute localization is

impossible, we not infrequently observe effects extending far beyond the parts actually enclosed in the circuit. By reflex action also we obtain remote effects which are either desirable or undesirable according to the demands of the case in hand.

Galvanization of the spine, and even of the extremities, may in certain irritable conditions excite the characteristic metallic taste. Galvanization, or even faradization, of remote and limited areas sometimes relieves pain, induces sleep, and increases the menstrual and other discharges through reflex influences alone. The effects of all local as well as general applications vary according to the length of the séances. The effect of the faradic current, when first applied by means of moistened electrodes, is to cause a tingling sensation, more noticeable at the negative than at the positive pole. In a short time the sensation becomes less and less marked, and a sort of anæsthesia is produced, enabling the patient to endure an increasing strength of current with no discomfort. The galvanic current, unless it be quite strong or directed over a motor-point, at first usually causes little if any sensation. In a short time, however, a slight burning sensation is experienced, rather more keenly felt at the negative pole. This sensation rapidly increases in acuteness until it may become absolutely unendurable; for, unlike the faradic current, the galvanic has not the same tendency to produce anæsthesia. There are two causes which probably account for this increase of pain, as well as of increased readiness of muscular contractions. The first is the fact that the conductivity of the skin becomes increased, not only through the moisture from the electrodes, but also through the greater activity of the circulation in the skin under the electrodes; and the second is the increased nerve-sensitiveness resulting from the stimulating effects of the current.

General Faradization.—In the administration of general faradization we employ, as is evident from its nomenclature, the faradic current alone. Its object is to bring the external portions of the body from the head to the feet, and as far as possible the internal tissues and organs also, under the influence of the current. The galvanic current may be used in this way as well, but it is so rarely indicated that I have not included it in the enumeration of the methods of application. Its chemical and reflex influences are so potent that, excepting in cases of rare and remarkable insusceptibility to influences of all kinds, its effects would prove harmful rather than beneficial. It is very seldom indeed that a case is seen in which general electrization is indicated—that the faradic current is not sufficiently powerful, either directly or reflexly, to excite the physiological activities.

In order to bring the whole body thoroughly under the influence of the faradic current the feet of the patient should be placed upon a copper plate, to which the negative pole is attached (Fig. 59). The soles

of the feet are not at all sensitive to the current, but if the patient is especially nervous or susceptible the feeling of constriction that is experienced in the ankles as the current passes, and the occasional contraction of the flexors and extensors may become disagreeable and even hurtful.

FIG. 59.

General Faradization : application to the spine.

In this case it will be better to apply the negative pole by means of a broad, soft sponge near the coccyx.

The positive electrode may be either natural or artificial. The hand is the natural electrode, and those who are able to bear the requisite strength of current through their own persons, and are willing to subject themselves to the fatigue which follows its frequent use in this way, will find it unrivalled by any other form of electrode. It is not absolutely necessary that the hand be used, but it can be readily understood that no artificial electrode that human skill can devise can equal the hand in its flexibility and the readiness and completeness of its adaptation to every inequality of surface. In all applications to the head, eyes, and face, and in the more general treatment of acutely susceptible patients and hysterical women, one will fail in numberless ways to obtain the same results by any form of artificial electrode. Ordinarily, however, when the applications are made along the course of the spine, and over the abdomen and lower limbs, the strength of the current necessary is too powerful to be passed through the arms

of any operator, and, fortunately, artificial electrodes answer here as good a purpose as the hand.

In submitting a patient to general faradization the operation should be with some regard to order. In the first place, the hair being thoroughly wet, the hand is passed with firm pressure over the entire surface of the head. In treating the forehead, which is far more sensitive to the current than any other portion of the body, the operator should first press his moistened hand firmly over the part, and then make the connection with his other hand on the sponge of the positive pole. The strength of the current when applied to sensitive parts of the body can be sufficiently regulated by increasing or decreasing the grasp of the positive pole held by the right hand. An application of the faradic current to the head in many forms of neuralgia, nervous headache, and insomnia, if properly given, is capable of affording instant and most grateful relief.

There are few, however, who administer it with any degree of precision or skill, and as a consequence we witness aggravation instead of relief of pain. The slightest concentration of current in such situations as the forehead is capable of exciting pain even in the normal condition, while a proper diffusion over a broad surface, with equal and gentle pressure, affords a sensation as agreeable as it is curative.

The back part of the head and upper portion of the spine (ciliospinal centre) will usually bear powerful applications; and it is an interesting and important fact that the applications to this centre will produce far greater tonic effects than when the pole is applied to any one other portion of the body. Care should be taken to avoid all bony prominences, since slight currents in these regions give pain. Hence over the scapula, clavicle, sternum, crest of the ilium, tibia, etc., care should be exercised in the moderation of the current. Let the first applications be tentative.

Experience will soon teach that there is no remedy to the effects of which there is such a varying degree of susceptibility as to this. A glance will not suffice, and frequently careful examination will fail to give information as to the proper strength and thoroughness of the treatment that should be first attempted. Not until the patient is submitted to a careful electrical test can we be sure that what we might consider very gentle treatment will not be too severe for the case in hand. As in the administration of localized galvanization, the current may be uniform or increasing. When the electrode is on the head, cilio-spinal centre, epigastric region, or pressed firmly on the various motor-points and nerve-plexuses, the current should be increasing. To make the applications successful, not only in the ultimate good, but also in that the patient experiences no subsequent weariness, soreness of the muscles, or vague but distressing nervous feelings, requires far more

care and experience than is generally supposed. On the part of the operator is demanded a certain degree of mechanical dexterity, entire familiarity with the instrument required, a complete knowledge of electro-therapeutical anatomy, a personal acquaintance with the sensations and behavior of all portions of the body under the different electrical currents, and close and patient study of the diseases and morbid conditions in which they are indicated.

General faradization is, to me, absolutely indispensable in the practice of electro-therapeutics. Beginning with the method many years ago, and at first confining my manipulations in electricity almost exclusively to it, I have not to this day seen cause to abandon its practice. There is no one tonic influence in medicine comparable to it in power; there is none to which can be accorded such a wide range of application; I can only account for its neglect on the part of those who profess proficiency in electro-therapeutics because of the time and labor requisite for its successful utilization, and the unwillingness of the physician to subject himself or his patient to trouble.

Central Galvanization.—By central galvanization we understand that method of treatment by which the whole central nervous system, brain, sympathetic nerves, and spinal cord, are brought under the influence of the galvanic current (Fig. 60). To accomplish this, one pole, usually the negative, is placed over the solar plexus, while the other is firmly pressed on the top of the head and gradually passed over the occiput, along the inner border of the sterno-cleido-mastoid muscle, from the mastoid fossa to the sternum, and from the cilio-spinal centre down the entire length of the spine. For this method, which we first introduced and described a number of years since, is claimed a distinct and important position. The different applications to the head and neck which have been variously used since the time of Remak are simply forms of localized electrization; but in central galvanization, as is observed, the poles are so placed that the whole central nervous system is brought under the influence of one pole—usually the positive—without disturbing the other.

Fig. 60.

Central Galvanization.

One reason that has been offered for rejecting central galvanization is the fear that its relations to electro-physiological laws cannot be fully explained. It is asserted that a remedy in order to be indicated in any special disease must have certain well-known physiological activities that directly meet or counteract the observed pathological conditions. To a certain extent this is true. For the relief of a dry skin and high pulse we resort to diaphoretics and arterial sedatives. To reduce the volume of blood in the brain we have bromide of potassium, and so on; but, on the other hand, can any one tell us minutely and satisfactorily why quinine has a controlling influence over the manifestations of malarial poison, why iodide of potassium tends to eradicate the syphilitic poison, or why opium causes sleep? And yet quinine is indicated in intermittent fever, iodide of potassium in syphilis, and opium in insomnia. That we cannot accurately localize the action of the current in limited areas of the brain has already been stated; but that external applications of the galvanic current penetrate directly to and appreciably affect it is thoroughly established, and the sedative and tonic effects that follow are well known to every one who has intelligently and thoroughly tested the method.

Central galvanization demands a far greater familiarity with the physics of the constant current, and with both functional and structural derangements of the central nervous system, than is possessed by many who essay its use. If there is any one therapeutical process in the whole range of practical medicine that more than another defeats its own legitimate ends through careless and ill-directed or ignorant applications, it is this. As a matter of experiment we submit a person in robust health and with no marked nervous susceptibility to central galvanization. If the current is gradually increased and as gradually decreased, without interruptions, few if any unpleasant sensations are perceived. The metallic taste is decided, the head experiences a sensation of fulness, and if the experiment be prolonged or the electrodes small, itching and heat will be experienced at either pole, and on the head (the seat of the anode) slight pain of a dull aching character may possibly be felt. A second person, of increased nervous susceptibility, will experience an exaggeration of all these phenomena, and subsequently may suffer from severe headache. Because of the symmetrical influence which the galvanic current, by the method of central galvanization, exerts on the brain, little if any dizziness is perceived by even the most sensitive patients; if, however, the current be passed transversely through the head, the so-called falsification of the muscular sense that results from an unsymmetrical stimulation (one pole affecting the right and the other the left hemisphere) is the occasion of immediate and intense vertigo.

In thus transversely galvanizing the brain the hemispheres are dif-

ferently influenced, and the result is a disturbance of the equilibrium. In conditions of health this dizziness, as a rule, passes off immediately on the removal of the electrodes, and is attended by no harmful results. In certain pathological conditions, however, and signally so when such conditions are associated with those peculiarly impressible nervous organizations that are so familiar, transverse galvanization of the brain is a highly culpable procedure. Let it be clearly understood, then, that in most cases this method should be avoided.

I might cite not a few suggestive cases, and not alone in my own experience, illustrative of the importance of this law; but it will perhaps suffice if I simply indicate a few guiding propositions. And, first, there is a certain class of patients, that I have just alluded to as being peculiarly impressible, who will in no degree be benefited by passing the current transversely through the brain; on the contrary, if there is mental or physical derangement from any cause, such application immediately aggravates the existing disturbance. In many instances there is no outward indication of any such susceptibility, and very frequently the most careful examination will fail to elicit a suspicion of any unusual relation of the nervous system to electrical stimulation. It is only when they are subjected to the test of actual treatment that idiosyncrasies are manifested that would not be distinctly revealed by any other method. In two exceptional cases, for example, of which I have records a current of comparatively feeble tension caused an astonishing excitation of all the nerves of special sense. Sight, taste, smell, and hearing were perverted and exalted; and that these evidences of excitation were not the result of fancy I thoroughly satisfied myself by unerring tests. In these cases, as in a number of others that enter as factors into the experience that guides these observations, the after-effects were only less unpleasant than the primary, and were disagreeably persistent.

Now, observe the effects of applications by the method of central galvanization in the same patients. The same tension of current causes a decided metallic taste (but no vertigo and no ringing in the ears), with a slight feeling of fulness about the head; and persistence in this form of treatment resulted in decided relief. In consideration, therefore, of these facts we should be ever watchful for these susceptible cases, and to avoid errors of judgment that might prove unfortunate we should not presume even on the most extended experience, but should in the beginning pursue a tentative course.

In the second place, we have in cerebral effusion and softening, and especially in cerebral congestion, conditions that call for care in any method of galvanizing the nerve-centres. In old apoplectic cases transverse galvanization of the head has often been used with no unpleasant results. There can be no doubt, however, that it might in many

instances prove exceedingly hazardous, and I have even seen unmistakable evidence of the ill effects (in producing dizziness and nausea) of an injudicious application of localized faradization in the neighborhood of the base of the brain and in the mastoid fossa. It is in the consideration of the symptoms of cerebral congestion, however, that we see most clearly the importance of rightly selecting our methods of electrical treatment. To give any direction to the currents excepting a longitudinal one (by which I mean from the summit of the head downward or from forehead to occiput) is, I believe, not only unphysiological, but contrary to the teachings of extended and carefully recorded experience.

In this connection, and especially with reference to central galvanization, an exceedingly important practical point arises concerning polar influence and current direction. Is the position of the poles or the direction of the current the more important factor in the production of therapeutical and purely physiological effects? The French school, and notably Legros and Onimus, denied the efficacy of polar influence in exciting physiological phenomena, ascribing them chiefly to current direction. They ascribed anelectrotonic effects to electrolytic action and to the induction of currents of polarization.

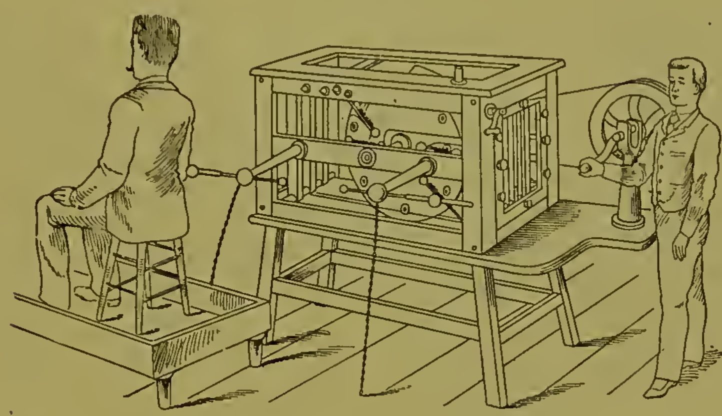
The contraction laws of Pflüger render it quite possible that in the electrical stimulation of a given nerve-piece the polar influence has more to do with the resultant physiological effects than the direction of the current; and according to this theory the relative position of the poles in central galvanization (anode above and cathode below) would seem, on physiological grounds alone, to be chiefly indicated for the relief of symptoms of central origin. Experience, at all events, strongly confirms its propriety.

It is very certain that in many conditions, and especially in true neuralgia and spinal irritation, therapeutic effects vary according to the position of the poles. In central galvanization few facts are better established, to my mind, than that certain conditions, such as cerebral congestion and forms of hysteria, may be injured rather than benefited by what are termed ascending currents, but whether the ill effects are due to current direction or polar action I am not prepared to say.

Franklinization.—By franklinization is meant the application to the body of franklinic or static electricity. The simplest form of treatment is by insulation (Fig. 61). In this method the patient is placed upon an insulating stool or table and connected with the conductors of either side according as a positive or a negative charge is desired. This silent reception of the electricity, and its silent and more gradual discharge from the body to the surrounding atmosphere, produce in most persons very pleasant effects. The hair of the head rises up, accompanied by an agreeable sensation, as if the wind were

playing gently around. The pulse may be slightly accelerated and the face become flushed, while after a time it is occasionally observed that a slight but general perspiration appears. This condition may fre-

FIG. 61.

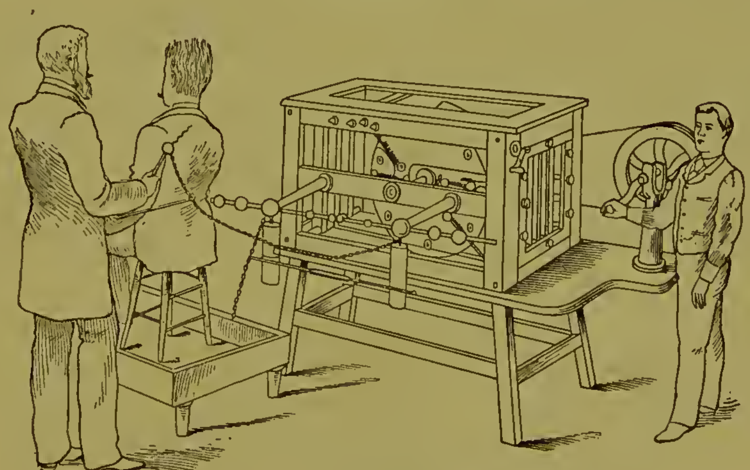


Static insulation.

quently be kept up with advantage for twenty minutes or so, until an agreeable feeling of drowsiness is experienced.

In the treatment by sparks or spray (Fig. 62) the patient is first

FIG. 62.

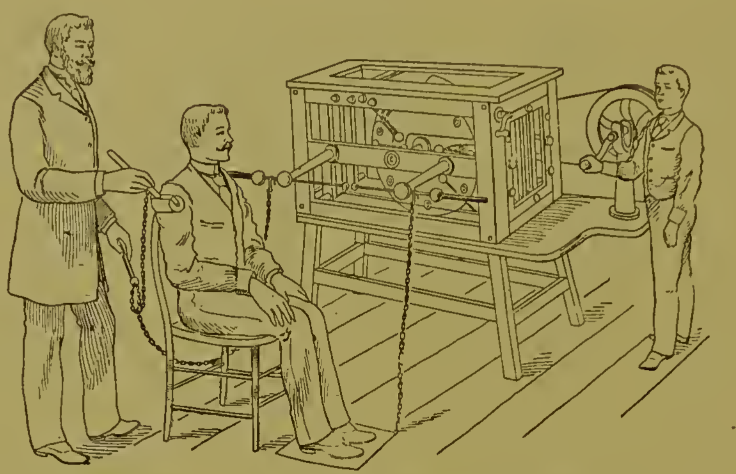


The direct spark.

put in the condition of insulation just described. Sparks can then be drawn from any portion of the body by the near approach of a conducting substance. Brass balls of various sizes, mounted on glass handles held by the operator, connected by a brass chain with the ground, or, better still, with the nearest gas- or water-pipe, are usually employed. As a substitute for general faradization, although by no means so generally effective and far less agreeable, the metallic roller may be used (Fig. 63). It acts reflexly and excites the cutaneous nerves most decidedly. When the roller is used upon the bare skin the conduction is so perfect that no sensation is appreciated. It is only when

the clothing intervenes that the peculiar pricking sensation is observed. It is needless to say that to obtain the best therapeutic effects of the roller it should be applied over the clothing. The electric wind, so

FIG. 63.

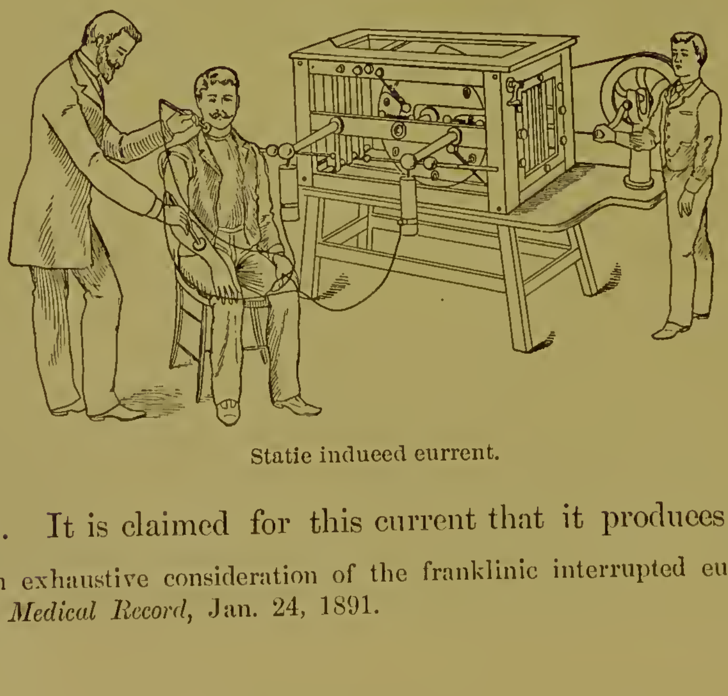


Treatment of metallic roller (general franklinization).

called, following the use of the pointed electrode, is due to the agitation of the air between it and the person treated. The discharge is silent and the effect exceedingly agreeable and refreshing.

Treatment by Shock.—This is a violent method, and not usually called for. It is produced by bringing the body, or that portion of it on which we wish to operate, in the circuit between the outer and inner coating of the Leyden-jar attachment. In addition, a static induction current, first described by Dr. W. J. Morton[1] of New York, can be obtained (Fig. 64). This has been suggested as a substitute for faradic

FIG. 64.



Static induced current.

electricity. It is claimed for this current that it produces maximum

[1] For an exhaustive consideration of the franklinic interrupted current see the New York *Medical Record*, Jan. 24, 1891.

muscular contractions with a minimum amount of pain, and that the response is quicker than that from the faradic current. As for the first claim, it is difficult to see how it can be determined, since the ordinary faradic current, from the single-coil apparatus especially, need seldom call forth pain in the production of muscular contractions. The change in the apparatus for the production of this current is quickly and easily effected, and for the purposes of localized electrization is most valuable. For general faradization, however, I can quite confidently assert that it is inferior to the current produced by the best faradic apparatus. That it possesses certain advantages, however, over the faradic current cannot be denied. Its voltage is enormous, and the alternations of each spark so rapid (millions per second) as necessarily to give it precedence in many respects over the ordinary induction current.

In order to obtain this current it is necessary to hang a pair of Leyden jars, as seen in the illustration, upon the arms of the machine. As the strength of the current is modified by the size of the jars, it is well to have several sets of different sizes. Rheophores to which ordinary sponge electrodes are attached are joined to the hooks that rest upon the outer coating of the jars. The strength of the current is in direct proportion to the distance apart of the two knobs of the discharging rods. These, therefore, should approximate closely at first, and be separated gradually as a stronger influence is desired.

The absolute value of franklinic electricity as a therapeutic agent is, without question, very great. Its relative value cannot be estimated with the same readiness, since conclusions on this point render it necessary to compare its effects with those of dynamic electricity. Any arguments, therefore, in the direction of showing that franklinic electricity has greater claims upon us as a remedy than has been generally believed must, of necessity, be quite valueless unless they are based upon long and thorough use of the different forms of dynamic electricity, especially by the methods of general faradization and central galvanization. The difficulty of obtaining reliable and exact information in regard to this matter will undoubtedly lie in the fact that in the future as in the past clinical reports will be too often given by those who have had no systematized or adequate experience in the use of dynamic electricity.

Sedative and tonic effects of a very interesting character are undoubtedly obtained through franklinization, but these effects are hardly equal in variety or degree to those that follow the careful and thorough use of dynamic electricity by the methods above mentioned. None the less, however, do we hail the recent revival of this neglected department of electro-therapeutics, not only because in certain conditions it may possess some advantages, but because, through peculiar idiosyn-

crasics, it is sometimes better borne than the other forms. It must not be forgotten, however, that, as a rule, general faradization is far more agreeable than treatment by sparks, however carefully given. Those who assert to the contrary do so through lack of experience or skill in the general method of administering faradism.

Of all the approved methods of using electricity, franklinization has the advantage of requiring the least skill and experience in its administration, and the disadvantage of necessitating apparatuses that are cumbersome, expensive, and not in the same degree reliable as the instruments for the generation of dynamic electricity. A still further advantage lies in the fact that little if any disrobing is necessary, since the drawing of sparks and the general stimulation of the surface are accomplished through ordinary clothing.

Another important reason for the use of franklinic electricity—and one which, to my gratification, I have thoroughly tested—is its occasional value in supplementing and reinforcing the constitutional tonic effects of general faradization.

It is one of the familiar things in medicine that a remedy which at first acts most effectually may, after a time, cease to have the desired effect. If, now, we substitute a remedy of the same class, even though it be inferior, further benefit often follows, and upon returning to the original treatment it acts with renewed vigor. The same principle holds good in regard to the dynamic and static forms of electricity. Occasionally cases of nervous exhaustion, as well as other forms of disease, after improving up to a certain point under the influence of galvanism or faradism, hang fire, as it were; but by submitting the patient to the action of franklinization a new impulse seems to be given. In this way, one treatment supplementing and reinforcing the other, results are obtained far more satisfactory than could possibly follow the exclusive use of general or localized faradization, central galvanization, or franklinization.

To determine the exact therapeutic status of franklinic electricity we need still to experiment and observe. A considerable experience, however, in its use would lead me to thus formulate what I believe to be the truth in regard to this matter:

First.—As previously asserted, tonic and sedative effects of a very decided character can be obtained from franklinization, by either insulation or sparks: these effects, however, are equal neither in variety nor degree, taking the cases as we find them, to the effects of dynamic electricity properly and thoroughly used after the methods of general faradization and central galvanization. As supplementing these methods, however, when in protracted cases they seem in a measure to have lost their effects, we have abundant testimony of its value.

Second.—It has long been known that many temperaments and

conditions of disease would bear faradization or galvanization readily, and yet shrink from electrization from sparks, while the reverse was not so evident. At the present time I have under my care two women, members of the same family both suffering from analogous affections. One regards general faradization as exceedingly agreeable, and is benefited by it, but shrinks from the treatment by sparks, and even dislikes the milder method of insulation, and complains of disagreeable sensations subsequently; the other much prefers the most positive treatment by franklinization.

Third.—In the enlarged joints of subacute and chronic rheumatism the treatment by sparks is frequently more efficacious than either faradization or galvanization. In the acuter stages of this disease, however, the descending faradic current affords greater relief. In old contractures and cutaneous anæsthesia franklinization may possibly possess some advantage.

Fourth.—As compared with the faradic current alone, franklinic electricity has undoubtedly some advantages in the treatment of some forms of neuralgia, but as compared with both the galvanic and faradic currents, I have been able to demonstrate no such advantage. Galvanism alone is superior to franklinism for the relief of pain, and yet the latter occasionally aids the former method not a little, on the same principle that it may be often used to supplement the use of dynamic electricity for the production of tonic and sedative effects.

Fifth.—In electro-diagnosis franklinic electricity (excepting the static induction current) is of but limited value, those qualitative and quantitative changes which are so important as indicating structural degeneration being satisfactorily made evident only through the action of the two forms of dynamic electricity. In electro-surgery also franklinic electricity is of but little value.

Electricity in Nervous Diseases.

In studying the physiological activities of electricity we are irresistibly led to the conclusion that its therapeutical action must be more especially in the direction of the relief and cure of nervous diseases. Experience thoroughly confirms this conclusion, and therefore he who makes much use of electricity in medicine will necessarily carefully study the neuroses. Much fault has been found with electricity because it fails to cure the graver forms of organic diseases of the nervous system; but it may be asked, Is there any therapeutic agent that will do this? As a rule, we use electricity in this class of affections for its symptomatic effects, and by relieving pain, paralysis, spasm, anæsthesia, and a variety of other symptoms much good is accomplished.

Electricity is essentially a stimulant, an exciter of living tissue; and whether the excellent results that follow its use in deep-seated struc-

tural diseases are due to its direct influence upon the diseased parts or to the peripheral impressions that it registers makes but little difference. Limited, therefore, as its value is in the graver forms of structural disease of the central and peripheral nervous system, it not infrequently acts with extraordinary efficiency in some of these cases, and gives rise to expectations in succeeding cases that are too often far from being fulfilled.

Electricity, however, has wrought its best results in neither central nor peripheral nerve-lesions, but in the variety of nervous disease rather that in our ignorance we have termed "functional."

Because we do not understand the pathology of functional neurasthenic disease, and are still unable to appreciate the errors of nutrition that undoubtedly underlie all these cases, it is no reason why we should not persist in the use of a remedy that has been of such splendid service in their relief. It has been said by Erb that we might as well do away with the bromides and arsenic in functional nervous diseases because we do not understand the theory of their action, as to abandon electricity because of our ignorance of the laws underlying its influence.

Neurasthenia.[1]—One of the most persistent as well as distressing forms of functional nervous disease is neurasthenia. It is claimed by some to be wanting in distinctive features and unworthy a place in the nomenclature of special diseases. Gowers in his great work *On Nervous Diseases* gives to it but a few lines, and most other authors allude to it briefly if at all. And yet the varying and varied forms of symptoms that so persistently group and regroup themselves in the multitudes who are so often told that they have no disease must mean something. These patients do not get well by being told that there is nothing the matter with them. Stereotyped tonic medicinal treatment, as a rule, does little good in these cases, and the effort to cure by favorably influencing the morale accomplishes about as little good in such conditions as it would in any case of true malaria.

One reason why neurasthenia has been so long neglected and is so little understood is that the symptoms are in some instances so subtile, illusory, and difficult of analysis and classification. One who has never seen and carefully examined a large number of cases of this disease would not believe it possible that it could manifest itself in so many different ways. No one example of neurasthenia illustrates more than a very small fraction of the great army of symptoms that has been observed in connection with this disease; and it is for this reason that so many have expressed doubts as to the propriety of any such formulation as neurasthenia.

[1] For a more extended discussion of this interesting subject the reader is referred to *A Treatise on Neurasthenia*, by Geo. M. Beard, M. D., edited with notes and additions by A. D. Rockwell, M. D. E. B. Treat, Publisher, N. Y.

Various forms of head-pain, noises in the ear, atonic voice, deficient mental control, hopelessness, morbid fears, and a host of other symptoms are readily enumerated as helping to make up the characteristics of its various types. These patients are also marvellously timid, and will delay for weeks and months before summoning sufficient courage to consult a physician and relate their woes. Now, in my own experience—and I think as well in the experience of every one who has given close practical attention to this matter—electricity not only greatly aids the action of other remedial agents, but it not infrequently cures where every other reasonable form of medication has failed.

While neurasthenia—a purely functional disease of the nervous system, a condition of profound impoverishment of the nervous force—is so often conquered by the judicious application of electricity, there is another set of symptoms that is very commonly mistaken for neurasthenia for which electricity is by no means so efficient a remedy. These symptoms depend upon a lithæmic condition of the system—faults of assimilation that are so readily mistaken for neurasthenia that very radical errors of treatment result. It might be suggested that the presence of uric acid in the urine ought to be a sufficient diagnostic sign, but uric acid is found in neurasthenic patients and is not at all times found in the lithæmic.

According to my own experience, one of the most common and distinctive points of differential diagnosis between lithæmia and neurasthenia is the difference in the character of the mental phenomena. Both the lithæmic and the neurasthenic suffer from mental depression and a profound sense of misery, more marked indeed in the former than in the latter condition. While, however, the neurasthenic may suffer from the deepest melancholy and imagine himself heir to a thousand ills, he becomes the victim, as a rule, of no such irritability and unreasonable outbursts of temper as the man whose brain is actually poisoned by the imperfectly transformed products of digestion. The neurasthenic may be at times extremely irritable, but this irritability is more passive than active, and any ebullition of angry feeling is quite evanescent. His demeanor is, as a rule, quiet, and there is but little manifest tendency to make those dependent upon him miserable by his words and actions. The touchy mood of the lithæmic, on the contrary, may last for days or weeks. It is due to actual toxæmia, is often if not generally accompanied by obstinate constipation, and may be relieved completely by the action of a cholagogue cathartic.

In neurasthenia, again, cold hands and feet are not by any means the rule, but in intestinal and liver derangements the nitrogenized wastes circulating in the blood cause, by their irritation, tonic spasm of the arterioles, resulting in the cold hands and feet so bitterly complained of by the sufferers from lithæmia. The condition of the

tongue is an important diagnostic aid. In lithæmia it is coated far more frequently and to a greater extent than in neurasthenia, but in some cases of lithæmia the tongue is but slightly affected. It may appear at first sight perfectly normal, and it is only when looked at carefully from the side that an unnatural brownish color is observed. It is in such cases as this that mistakes in diagnosis are frequently made. As regards the pulse, it may be said that in lithæmia it is slow rather than fast, and in neurasthenia fast rather than slow. In neurasthenia the oxalates are frequently found in abundance, while in lithæmia the oxalates are not usual.

These cases of lithæmia, when mistaken for neurasthenia, as is not infrequently the case, and treated by electrieity, yield most unsatisfactory results, and their points of differential diagnosis cannot be too carefully studied. The neurasthenic patient, on the contrary, will almost invariably receive benefit more or less pronounced by rightly adapting methods of electrical treatment to his condition. General faradization, central galvanization, and statie electricity have all been found to be serviceable, but in different degree and under different conditions.

There is certainly no absolute standard of differentiation in the use of the various forms of electricity, but in those cases in which morbid fears predominate central galvanization or simple galvanization of the brain are especially indicated. With these symptoms we have, mostly, cerebrasthenia or brain-exhaustion, and under the influence of this exhausted condition the emotional nature overcomes reason and will. The results of galvanization of the brain do not perhaps show immediately, but little by little beneficial effects are observed, leading up in many instances to complete recovery.

Neuralgia.—Electricity is of the most decided value in the treatment of neuralgia. While failures follow the most skilful manipulations, and exacerbations of pain not infrequently result from careless and ill-directed applications, it is safe to say that the great majority of cases of neuralgia, not dependent on serious organic lesions, receive more or less benefit from proper electrical treatment, and in many cases the distressing pains dependent on central structural changes are also very decidedly alleviated. The relief of pain is one of the prime functions of medicine; and the question, therefore, as to the form of current best adapted for that purpose is of much importance. There can be no question that galvanism has a wider range in this direction than faradism; yet in consideration that the latter has been very much ignored it seems necessary to say a word in its defence. My experience will not allow me to doubt that faradism is not only invaluable in many forms of pain, but relieves in certain conditions in which galvanism is not only useless, but worse than useless, since it serves

only to increase the existing distress. When, then, a case of neuralgia presents itself for electrical treatment two questions at once arise: First, What form of current is indicated? Second, What method of application?

True neuralgia, as defined by Anstie, is, without doubt, most successfully treated by galvanism, while hysterical neuralgia and the so-called pseudo-neuralgia, which are simply forms of pain occupying certain areas and running seemingly in the direction of certain nerves, yield most readily to faradism. More specifically, the effects of pressure in the various forms of neuralgia are exceedingly useful as guiding symptoms, indicating the proper current. I do not by any means lay it down as a universal law, but it will certainly be found that in the great majority of cases of neuralgia when firm pressure over the affected nerves aggravates the pain, the galvanic current is indicated, while the faradic current has the greater power to relieve when such pressure does not cause an increase of pain.

In the class of cases sometimes called hysterical hyperæsthesia it is well known that firm and prolonged pressure affords marked relief, while pressure superficially or lightly applied increases the pain. The faradic current is here infinitely superior to the galvanic.

In rare cases of excessive pain associated with anæsthesia—a condition which I have encountered in not a few instances—strong and coarse (slow intermittences) currents of faradism are of positive service. Neuralgia of the scalp is sometimes of this kind, and in these cases currents that would prostrate a strong well man are found to be painless and curative.

The revulsive method of treatment by the faradic current consists in faradizing the skin. This is accomplished either by applying the solid metallic electrode or the metallic brush.

The physiological action of the good results that have been known to follow this harsh and painful method of treatment is thus explained: "Electrization of the sensitive nerves determines a non-active flow of blood, and, as neuralgias are usually accompanied by modification in the capillary circulation, it follows that the augmentation and acceleration of the flow of blood may lead to the removal of the painful symptoms."

It should not be forgotten that many neuralgias are developed along with diseases that are constitutional. The neurasthenic and hysterical patients and those suffering from other constitutional anomalies are frequently the victims of severe local neuralgias. In these cases it is useless to rely on any form of local treatment, and general faradization and central galvanization often act admirably in relieving the local pains. In neuralgia, perhaps as much as in any symptom of disease with which we have to deal, the electrical treatment should at first be tenta-

tive. In the beginning mild currents only should be attempted. If the faradic current is used, and the part affected is any portion of the scalp, forehead, face, or neck, the use of the hand as an electrode is far more agreeable to the patient, and is attended with better results than with any form of artificial electrode.

In those forms of neuralgia that are symptomatic in character—those that are associated with diseases of the brain and spinal cord—severe peripheral nerve-lesions, and especially in that form of facial neuralgia known as tic-doulouroux, electricity is of doubtful value, or at least is only palliative in its effects. In idiopathic neuralgias, however, in those depending upon rheumatism and neuritis, anæmia and neurasthenia, favorable results may be hoped for.

So far as the direction of the current is concerned in the treatment of the various forms of neuralgia, I am persuaded that on the whole descending currents are preferable to ascending, and, as to polar effects, the positive pole is, in my experience, superior to the negative in its generally calming effects.

Chorea.—I know of no disease in which there are stronger indications for the use of electricity than cases of chorea that have assumed a chronic form. As is well known, the majority of cases occurring in children recover either spontaneously if proper care is exercised, or through the administration of some nerve tonic; and the test of the obstinacy with which this disease will resist treatment is not so much the severity of the choreic disturbance as the length of time it has continued. We may find a simple twitching of the corner of the mouth, that has lasted for years, entirely incurable; while the most violent paroxysms, associated with frothing at the mouth and inability to articulate, may disappear in a few weeks. It is the readiness with which the ordinary case of chorea tends to recover, quite as much as the efficiency of remedies, that has given such repute in this condition to various medicines, such as iron, zinc, arsenic, and strychnine. The surprising lack of unanimity of opinion concerning the treatment of the disease confirms, more than anything else, this belief in its general tendency to recover. When, however, a case (be the movements general or local) has continued without amelioration for several months, it may be considered chronic, and will be more or less difficult to cure. In such a case I regard electricity in some form far superior to any and all other methods of treatment. The two methods that have in my hands been most efficacious are general faradization and central galvanization. While the ascending galvanic current is to be preferred in the treatment of chorea located in a single muscle or in a group of muscles, I very confidently assert that general faradization is far more efficacious when the disturbances are at all general. If the applications

are skilfully made, they will act both as a tonic and as a sedative to allay irritability and induce sleep.

Epilepsy.—That electricity is of some value in the treatment of epilepsy I have for a long time believed, and while my observations in this direction do not enable me to assert the exact measure of benefit that we may hope to derive from its use, either alone or in conjunction with approved methods of treatment, they may perhaps throw some light on the subject, or at least awaken an interest that may lead to a more extended experience as well as to a greater accuracy of observation. I wish to say, first, that in many instances in patients who have been submitted to central galvanization—galvanization of the sympathetic—or to general faradization, a profound tendency to drowsiness has been observed. In some cases sound sleep has for a few moments been induced with the subject in an upright position while receiving the current through the brain. I recall one patient under treatment by central galvanization who was repeatedly put to sleep within a minute after the beginning of the application.

Accepting the theory that a state of cerebral anæmia predisposes to sleep, it is not very difficult to believe that the feeling of drowsiness that so often follows central galvanization, and even general faradization when specially directed to the cervical ganglion, is due to the direct action of the current on the vaso-motor nerves.

It seems hardly necessary at this date to attempt a detailed argument in proof of the very decided action of electricity in any of its manifestations on the arterial circulation.

The well-known effects of direct applications to the sympathetic of the living animal, the results following external applications to the sympathetic observed through the ophthalmoscope and by means of the sphygmograph, and other physiological experiments, have long attested this power of the current.

Among experiments are those of O. Tschetschott[1] and Przewaski,[2] who have investigated the action of galvanization of the sympathetic. The latter found that a lowering of temperature of one side of the face occurs upon faradization of the corresponding ganglia, the decline of temperature ranging from 0.5° to 1.75° Cent., according to the length of the application. In the same way he found that faradization of the ulnar nerve is followed by a decrease of from 0.7° to 2.53° Cent. in temperature in the region between the third and fourth fingers supplied by this nerve. Tschetschott's results are similar.

I have lately had under treatment a patient who has been under the care both of the late Dr. Peaslee and of Dr. Janvrin, and who illustrates, better than any case I ever saw, this control that electricity has

[1] Abstracted in the *St. Petersb. med. Wochenschr.*, Oct., 1876.

[2] *Deutsche med. Wochenschrift*, No. 43.

over the circulation. For several years the patient has been a great invalid from uterine congestion and displacement, and, although now much better of her local troubles, suffers night and day from excessive action of the heart. This activity is altogether functional in character, and in a measure probably dependent on reflex influences, for increase of local pain invariably accelerates the pulse. The pulse is usually between 95 and 120, but it frequently rises as high as 160. When at the latter point an application of general faradization invariably reduces the pulse from 40 to 50, and sometimes 60, beats. When no higher than 125 to the minute, a similar application reduces the number about 30, and when the pulse is beating with its usual frequency, say 95 to a minute, the treatment brings it down from 5 to 10 beats. I have tested this case thoroughly and carefully, and find that no local applications of either the galvanic or faradic currents will give as satisfactory results as general faradization. It is needless to say that the relief following such application is considerable, and the tendency to this unusual excitation seems to be growing less and less.

A case that suggested a certain similarity between the action of bromide of potassium and electricity occurred in the person of a lad aged twelve years. The case was one of *petit mal*, and for two years the attacks occurred from six to ten times a day. In ten-grain doses bromide of potassium reduced the paroxysms to one, two, or three in the twenty-four hours. This improvement continued for a month, when, notwithstanding the increased doses of the bromide, the attacks gradually increased in frequency. General faradization, with galvanization of the sympathetic, was then resorted to, and the results that followed were substantially the same as those obtained from the bromide. The epileptic seizures were reduced to from one to three a day, but after a few weeks they returned with their usual frequency. Subsequently, in two other cases of *petit mal* that came under my notice, the same similarity in the action of the bromide and electricity was noted. Recovery followed in one of these cases. The patient, a girl aged eleven years, first observed the attacks in the early part of 1884, and came under my observation in March, 1885. At first the paroxysms occurred but once or twice a week, but in about six months they began to increase in frequency, and for several months before I saw her she was having them as often as once, and sometimes three times, a day. The attacks were of short duration, lasting not more than half a minute to a minute and a half, and although for the time there was perfect unconsciousness, yet the patient, if standing, as was usually the case, never fell, but if engaged in any occupation immediately resumed it after the attack had passed away. I used at first the bromide of potassium alone, and pushed it until the face was covered with acne. As in other similar cases, she improved very decidedly through several

weeks, and then rather quickly relapsed. It is proper, however, to state that this relapse may have been due to a neglect, to which she confessed, of regularity in taking the medicine. I then subjected her to central galvanization and general faradization, alternating the methods and allowing a day to intervene between each application. She improved much less rapidly than under the bromide, but the improvement that followed was retained. At the end of three months she was having but one attack in a period varying from ten days to two weeks, and in just eighteen weeks from the beginning of treatment she had her last attack.

Another satisfactory case was in the person of a peddler, aged thirty-two, who entered my office for the purpose of disposing of his wares, March 14, 1877. The man was of respectable appearance and average intelligence, and while conversing with him he had a slight epileptic seizure, and would have fallen from his chair if I had not supported him. When consciousness returned, after what seemed to be a very short period—perhaps not longer than one or two minutes—he seemed to recognize the fact that the attack had been of short duration, and on inquiry gave the following history: He was a native of England, had been in this country two years, and had had his first epileptic attack eighteen months previously. As near as he could remember, the second attack occurred after an interval of six weeks—the third in four weeks; thereafter they gradually increased in frequency, and during the last six months had occurred as often as twice a week. Most of the attacks were light and soon over, as the one that I witnessed, but at least once a month, as he informed me, they were much more severe—the aura being recognizable—with slight lacerations of the tongue. He had been under no professional care, but had taken a good deal of "salty-tasting medicine," administered to him by some druggists. He recognized the name of bromide of potassium, and said he thought that it was the medicine.

Upon proposing that he submit himself to my treatment (gratuitously of course), he readily consented, and, thinking it to be a good and fair opportunity, I placed him under central galvanization, with occasional séances of general faradization. I treated him every day excepting Sundays (when I was out of town) for six weeks. On March 16th he had one of his severe attacks; March 22d, one of the slighter seizures; March 31st, another slight attack; April 14th, a third attack of a mild character. On April 20th a paroxysm of the more severe type took place, but evidently considerably modified in intensity and duration.

This was the last severe attack that he had. On May 4th he said that during the morning he thought that he had experienced a very slight paroxysm, but it was so transient that he was hardly aware of it. I

saw no more of him until the following September, when I accidentally met him on the street. He looked well, said that he had had no more attacks, expressed gratitude for the services rendered, and promised to call at my office, but failed to do so.

Dr. Meredith Clymer, in some excellent remarks on the treatment of epilepsy, states that he has never heard of a permanent cure of the disease under the use of the bromides, either alone or in combination. While we may regard this as an extreme statement, the suggestion that the best results will follow only when we call to our aid every measure that will tend to increase and develop vital power generally commends itself to all. It is not alone, therefore, on the theory of a special influence on the nerve-centres or over the cerebral circulation that we employ electricity as an adjuvant to the bromides, but also because of its undoubted and powerful constitutional tonic effects. In this, therefore, as in various other forms of central disease, I invariably associate and alternate general faradization with central galvanization.

Exophthalmic Goitre.—The opportunities for post-mortem examination in cases of Basedow's disease have been so few that its pathology is far from being satisfactorily ascertained, although it is true that very positive results have rewarded certain researches into the condition of the sympathetie. In eight cases structural change was discernible, although in a number the change was so slight as to be hardly recognizable, while in four cases not the slightest lesion could be detected. It seems fair to conclude, therefore (accepting the neurotic theory of the disease, rather than Basedow's hypothesis of a primary chlorotic affection, or the cardiac theory of Stokes), that the symptoms of exophthalmic goitre may proceed from purely functional as well as from organic disease of the sympathetic or any part of the central nervous system. In those cases that resist every form of treatment it seems quite probable that examination of the nerve would reveal greater or less diminution of the nerve-elements, together with gray infiltration and increase of the connective tissue, since these were the most important changes observed in the eight cases alluded to above; while curative results, such as have occurred through electrical and other methods of treatment, could have been obtained only when the conditions belonged to the class of so-called functional neuroses.

The benefit to be derived in cases of Basedow's disease from persistent and well-conducted treatment by electricity is far from being sufficiently appreciated. In the treatment of over thirty cases the method has in my hands been so successful in many of them that I urge its persistent use in every case. I may be allowed to detail a case, not only as an excellent example of the benefit that may follow this method of treatment, but as an illustration of the technique of the electrical application: The patient was a man aged thirty years, and had

been subjected to much mental disturbance and anxiety, which may have been important factors in the etiology of his disease. He was nervous and excitable, and when he first came to my clinic his pulse beat uniformly at the rate of 120 to the minute; there was, however, no enlargement of the thyroid, and only slight though perceptible protrusion of the eyeballs. While, therefore, the case is undoubtedly to be classed under the head of the disease under consideration, it was yet an incomplete type of Basedow's disease. The complete form of the disease is where the three cardinal symptoms—viz. accelerated heart-action, protrusion of the eyes, and enlargement of the thyroid—coexist. In such cases there can be no question as to the diagnosis, but where there are neither eye-symptoms nor thyroid enlargement, and even in such cases as this, where there is no goitre and only a very slight exophthalmus, we cannot always be so sure as to its correctness.

The essential feature of the disease, however, is the rapid pulse, due to some interference with the inhibitory power of the vagus, and true Basedow's disease may exist, represented by the single symptom of rapid heart. The diminished electrical resistance which Vigouroux claimed to be uniformly present in these cases does not seem to me to be of special importance as a diagnostic sign. In the case just referred to the resistance was 1500 ohms, somewhat less than when the test was applied to myself, but this difference was readily accounted for by the better conductibility of the skin of the patient, which at the time was quite moist with perspiration. In regard to these observations of Vigouroux and others concerning the diminished electrical resistance that has been noted in Basedow's disease, it does not seem to me that they can be of any special practical importance, diagnostic or otherwise. Every physiological consideration and all experience point to the galvanic current as pre-eminently indicated.

The faradic current is, however, not altogether useless, but its application must not be local, but general, after the method of general faradization, and in a certain proportion of cases in which there is anæmia, with marked nervous irritability, more or less benefit may be confidently expected. In the treatment of this case by the galvanic current the cathode was placed over the cilio-spinal centre, just above the seventh cervical vertebra, and the anode in the auriculo-maxillary fossa. After a few moments of stabile treatment the anode is gradually moved along the inner border of the sterno-cleido-mastoid muscle to its junction with the clavicle. The operation is then repeated with the anode upon the opposite side, and finally, changing both electrodes for those of much larger size, the anode is placed in the position first occupied by the cathode, and the cathode transferred to the solar plexus. With the small electrodes in the first position the milliampèremeter indicated a current strength of only ten milliampères, while

with the large electrodes in the second position (the same number of cells remaining in the circuit) the strength of the current was increased to fifty milliampères without special discomfort to the patient. Under this method of treatment, alternated with general faradization, the pulse of the patient was gradually reduced to 85; he became far less nervous and excitable and was discharged as approximately if not completely cured.

While I consider electricity the main reliance in the treatment of this disease, yet the most rigid and conscientious observance of certain fixed rules in regard to eating and drinking, and the avoidance not only of excess in every department of mental and physical hygiene, but the repression of ordinary and legitimate emotions and passions, becomes absolutely essential.

Paralysis.—Instead of attempting to discuss electricity as it relates to the multifarious manifestations that come under the head of the generic term "paralysis," I propose to give some observations of a general character, but which are yet applicable to almost every individual form of paralysis. If the galvanic current is passed continuously for a time along the course of a nerve its strength increases in a marked degree. One factor that goes to make up this increase, as is well known, is the better conductibility of the tissues gradually taking place at the seat of the recomposition of the current—a result due to congestion of the skin and adjacent parts under the electrodes.

That this explanation, however, of the increasing strength of the current where continuously passed through living tissues is but partial can be readily demonstrated. I apply the current from a given number of elements to the arm and forearm, and seven milliampères are immediately registered. In one minute there is an increase of one degree; in two minutes, an additional degree; and in eight minutes twelve milliampères are registered. That this extraordinary increase of strength is not caused by improved conduction alone I soon satisfy myself by applying vigorous friction to the other arm, and when the congestion is as intense as that produced by the electricity the electrodes are applied. Instead of seven, the instrument does indeed immediately register ten milliampères, but it is not until four more have elapsed that the additional two degrees are registered.

Another phenomenon, even more interesting than this, is the increased strength observed upon a reversal of the direction of the current. A current of fifteen cells was applied to the thigh of a patient (small electrodes being used), and the poles kept in position until twelve milliampères were registered. The current was then suddenly reversed, when the milliampèremeter immediately registered fourteen. To analyze the molecular disturbances that evidently take place during the passage of the galvanic current is a labor of the

greatest difficulty, and the phenomenon is one not yet thoroughly understood. Evidences, however, of the chemical action of electricity as it passes through the tissues are not wanting, and the sudden increase of strength is undoubtedly due to the electrolytic or polarizing action of the current exciting a secondary current in the living body similar to what is observed in a reservoir or secondary pile.

In contrast to this thoroughly scientific and demonstrable doctrine of Matteuci, we have the more vague and confused teachings based on the theory of electrotonos, the laws of which, while of great value, do not by any means account for all the phenomena and therapeutical activities of the galvanic current. On the other hand, the statement "that a therapeutical system, built on the opposite anelectrotonic and catelectrotonic effects rests upon an imaginary basis,"[1] seems to me altogether too sweeping.

To appreciate intelligently the force of those barbarous terms anelectrotonos and catelectrotonos, we must keep in mind the purely physical effects of the current in the tissues. These effects are exceedingly complex, for the composition of all organic tissues is complexity itself. Combinations and decompositions take place which are yet of an entirely unknown character.

The analogue of the electrolysis of organized tissue—animal or vegetable—although less complex in its nature, is seen in the electrolysis of acidulated water.

Acids go to the positive and alkalies to the negative pole : now it is a fact of physiology that acids diminish the irritability of nerves, while alkalies increase it. Anelectrotonos and catelectrotonos may therefore be caused by acids at the positive and alkalies at the negative pole. However this may be, it is as true now as when first demonstrated by Pflüger, that a nerve is *excited* by the appearance of catelectrotonos and the disappearance of anelectrotonos, but not by the appearance of anelectrotonos and the disappearance of catelectrotonos. In other words, irritability is increased near the negative pole, this condition of catelectrotonos increasing as the current runs up to a certain point. On breaking the current the negative modification, or condition of diminished irritability, appears for a moment and then disappears. Near the positive pole, on the other hand, the irritability is diminished after closing the current. On breaking the current there is an increase of irritability or positive modification, which appears to be greater when the current has been allowed to run a long time. But, whatever theory we accept, the fact remains that it is not alone the increased conductibility of the tissues that enables the current to act with such increased vigor, but phenomena of a purely physiological or physico-chemical order. It is in the consideration of paralysis in its various

[1] "Conditions of the Unipolar Stimulation," etc., *Brain*, Part ix.

forms, more especially, that these cumulative effects of electricity would seem to be of value, but experience points to other conditions in which it is applicable. In paralysis of central origin, when there is increased irritability of the paralyzed nerve, any attempt to produce muscular contractions is uncalled for and may do harm. The continuous passage of a galvanic current, however, is useful, and, provided no interruptions are allowed and the current is not reversed, a moderate modification of the excessive irritability may be quite confidently expected.

In cases of hemiplegia, when the irritability of the nerve is more or less impaired, the continuous passage of the current accomplishes more for the patient than the attempts at frequent muscular contractions that are so popular. The difference in the treatment of hemiplegia with increased nerve-irritability and hemiplegia with decreased nerve-irritability is simply this: In the former it would be as inadmissible to allow interruptions of the current or a change in its direction as it would be in a case of neuralgia. In the latter, on the contrary, a few interruptions can with good effect be given at the close of an uninterrupted séance, and a reversal of the current adds to the efficacy of the treatment. My attention was called to the practical value of what I term the cumulative effects of electricity by observations more particularly in various forms of peripheral paralysis and in the essential paralysis of childhood. I have, of course, treated many cases of infantile paralysis, and, in common with others, have had both successes and failures; and up to within a few years all of these results, both good and indifferent, followed the rough and excessively stimulating method of current-interruptions. Before electricity had the slightest recognition as a constitutional tonic and sedative, and as such was indicated in a great variety of disorders, it was rather contemptuously assigned the position of a harsh stimulus and of some value in "pricking up paralyzed muscles."

No statement of the damage inflicted by the practical application of this crude and primitive enunciation has ever been made, but I am confident that great and fatal mistakes have arisen therefrom.

Two cases of infantile paralysis have come under my observation in which but the slightest suggestion of nerve-irritability existed, and when, after rough usage—in one instance by the faradic and in the other by the galvanic current—the slight vestige of vitality in the paralyzed members became extinguished and the cases hopeless. On the other hand, I have seen cases in which the nerve-irritability was equally impaired pursue an entirely different course under an entirely different method of treatment. Sudden galvanic shocks, whatever useful purpose they may occasionally serve, are often extremely dangerous. Their effects are, in the main, undue stimulation, and, in their relation to nutrition, destructive rather than reconstructive.

The continuous passage of the current, however, while in a certain sense stimulating in its effects, combines influences that are sedative and tonic, and pre-eminently reconstructive, and is alone equal to the task of resisting progressive degenerative changes in nerve and muscle. I could easily cite a number of cases of infantile paralysis as illustrative of the principles here enunciated, but will only give, with some minuteness of detail, the history of a single case. It was in the observation of this case more especially that I became thoroughly alive, on the one hand, to the importance of the continuous action of the galvanic current, and, on the other, quite as positive as to irreparable damage to nutrition, in conditions both of increased and diminished nerve-irritability, by the injudicious use of the interrupted galvanic current.

In October, 1884, a boy, aged five, was brought to my office suffering from complete paralysis of the right leg, and, in a less degree, of the left also. The muscles of the right thigh and leg had atrophied to such an extent that the bones seemed to be covered with little more than skin, and it is hardly necessary to say that to the faradic current there was not the slightest reaction. The galvanic current also seemed at first unable to elicit any evidence of nerve-irritability, but upon more careful electrical interrogation exceedingly slight contractions of some of the extensors of the foot were observed, but associated with decided qualitative changes.

In the left leg, which had atrophied to a considerable extent, I found quantitative changes, but no reaction indicating tissue-degeneration. About a year previously the child had been seriously reduced in flesh and strength by a prolonged diarrhœal attack, culminating in a series of severe convulsions, followed by fever, and associated, probably, with acute polio-myelitis anterior. Paralysis of the legs followed, and for a few days the loss of voluntary motion was complete. Within a week, however, without special treatment the limbs gradually began to resume their function, until the patient could freely move them, the left one becoming sufficiently strong for him to bear his weight upon it.

Improvement seemed to stop at this point, and some time subsequently the mother, although not a poor woman, sought advice at one of our college clinics. Here electricity was used, and, according to the statement of the mother, the foot became rapidly extended many times in rapid succession during the application. This process, evidently a strong interrupted galvanic current, was repeated quite a number of times at varying intervals, until finally the observant mother noticed that not only were the contractions less marked, but the power of voluntary movement in both limbs was decreasing in a decided degree. She ceased her visits, abandoning all treatment, but the limbs steadily continued to decrease in strength and size, until, when I saw the child, the left leg had reached, as already stated, an extreme condition of atrophy, with

marked reaction of degeneration in the few muscles that still retained some slight evidences of electro-muscular contractility. The case seemed sufficiently hopeless, but, explaining to the mother, who dreaded any further trial of electricity, the entirely different method that would be adopted, and impressing on her mind the necessity of patience, I began the application of the uninterrupted galvanic current with a strength of only five milliampères and a séance of five minutes in duration. The applications were for a time made daily, and at each sitting the duration was increased by one minute and the strength of the current by one milliampère, until at the end of two weeks the patient was receiving applications of fifteen minutes and a current-strength of fifteen milliampères.

During this time, although reversed currents were used every day, not a single galvanic interruption had occurred. Examining now the condition of electrical excitability, I was gratified to find not only increased vigor in the contractions of the extensor muscles, but slight yet appreciable contractions in muscles which had before failed to respond to the most searching electrical interrogation. The reactions were yet, however, those of degeneration. This patient continued under observation and treatment a long time, the limbs improving from month to month in nutrition, and necessarily in electrical reaction. At the end of eight months the patient could walk aided by a cane, although with considerable awkwardness, and the electrical reactions were normal, with the exception of a slight quantitative defect in the left leg, which continued also quite deficient in size. The lessons to be learned from this case are undeniably important.

If the mother could be trusted in her statements—and she was an unusually intelligent and observant woman—the main points were these:

Following an attack of acute polio-myelitis anterior we have the characteristic paralysis of the lower limbs. Spontaneous improvement, but only up to a certain point, soon appears. Shortly after, strong interrupted galvanic currents are most imprudently administered, resulting finally in almost entirely obliterating a condition of nerve-irritability that was already greatly impaired. The damage inflicted was almost irreparable. The muscles waste and the reaction of degeneration appears.

Finally, when the paralysis was practically complete, the aid of a mild continuous galvanic current was evoked, and increased from time to time as prudence dictated. Nutrition is immediately and favorably influenced—the muscles increasing in size and strength, the electrical reactions becoming normal, and, in the end, the disabled members are sufficiently restored to be of decided service. In various other forms of disease these principles are no less applicable than in paralysis, the

difference being that, while in neuralgias and most nervous symptoms it is more universally understood that continuous currents are indicated, in paralysis it is too often taken for granted that the more prompt and vigorous the stimulation the greater the benefit.

The injury that may be inflicted upon paralyzed members by this method has already been emphasized, but it is to be observed that such injury does not as a rule follow occasional or accidental shocks, but only when administered with a good degree of vigor and as a supposed necessity of treatment.

It has been denied that electricity exerts any favorable influence over the process of peripheral-nerve degeneration, and, as facial paralysis is among the more important peripheral nervous diseases, it will be interesting to consider the questions: 1st. Does electricity sensibly hasten recovery in cases of peripheral facial paralysis? 2d. In what class of cases is it especially serviceable?

A case, briefly stated, will aid in answering these questions:

The patient was a woman who came to me a short time since suffering from typical facial paralysis of the right side. Seven weeks before she awoke in the morning only to find her face paralyzed. She immediately went to her physician, who applied the faradic current and repeated the application daily, Sundays included, for seven weeks. At the end of that time there was no improvement. He then came with her to my office, when I found no reaction to faradism, but, on the contrary, a greatly *increased* reaction to galvanism. The uninterrupted galvanic current was substituted for the faradic, and in a few days a decided improvement was manifest. It required a decreasing strength of galvanism to produce contractions of the facial muscles, and on the sixth day farado-muscular contractility appeared, and within a month the muscles contracted normally to both currents, and the paralysis had approximately disappeared.

Such a case as this not only helps to answer in the affirmative the first question, Does electricity sensibly hasten recovery in peripheral paralysis? but also gives a clew as to the class of cases that are most benefited by the current. The faradic current causes contractions through its action on the intramuscular nerves, and not on the muscular fibre, while the galvanic acts powerfully on muscular fibre and less vigorously on intramuscular nerves. When, therefore, a muscle is deprived of its nerve-influence in any way, the faradic current is powerless to contract it, while galvanism not only causes contractions, but calls them forth even more vigorously than in health; and this in proportion to the strength of the current and the slowness of the interruptions. In cases similar to the one to which allusion has been made the intramuscular nerves are undoubtedly paralyzed from the beginning, but the muscular fibre is intact, and, through checks to

inhibition or faulty nutrition, we see a remarkable increase of galvano-muscular contractility. While the cases, according to my observation, that respond most promptly to electrical treatment are those that present this anomalous reversal of muscular contractility to galvanic interrogation, rather than those in which there exists an impaired reaction to both currents, we yet find many cases of lost farado-muscular contractility associated with increased galvano-muscular contractility that show little tendency to progress rapidly under electrical treatment. Such are the cases that we might naturally suppose to be dependent upon a neuritis within the Fallopian canal.

I cannot indeed see how electricity can be of much use in cases of facial paralysis caused by a neuritis within the bony canal and the consequent swelling and compression of the nerve-fibres; but it is not difficult to understand how it can be of service if the nerve-terminals alone, or that portion of the nerve external to the Fallopian canal, are mainly affected. Gowers, in his great and conservative work on nervous diseases, insists that there is no evidence that cold ever paralyzes the intramuscular nerves, and doubts whether inflammation ever affects the nerve after its emergence from the canal. If this is true, then it is difficult to account for some of the rapid recoveries that have taken place in cases that were apparently stationary, when subjected to the proper current.

While admitting that electricity possesses only a limited range of usefulness in severe lesions of either the central or peripheral nervous system, I think it is one of the most efficient remedies we possess for the relief of the various symptoms associated with these lesions, while for the removal of the finer nutritive disturbances that underlie many persistent neuralgias the galvanic current is certainly a remedy of the greatest value.

But whatever good is accomplished by the current in arresting degenerative processes in nerve and muscle, it must be through attention to the details of methods of application.

Years ago my attention was called to the irreparable injury that may accrue from sudden galvanic shocks in certain cases of paralysis. These observations were made more especially in the essential paralysis of childhood, but are equally applicable to cases of peripheral paralysis; and therefore in any case of this type in which there exists either marked decrease or increase of electro-muscular contractility or irritability, and especially when we have associated the characteristic "reactions of degeneration," it is far better treatment to avoid frequent interruptions of the current, the effects of which, as before remarked, are undue stimulation, and in their relation to nutrition destructive rather than reconstructive.

Whatever power this agent possesses to resist progressive degene-

rative changes in nerve and muscle, it is more by its continuous passage and the induction of those cumulative effects that come from current reversal without shock than the ordinary method of slow or rapid interruption.

As in facial paralysis, the ultimate tendency to recovery in diphtheritic paralysis renders it a matter of no little difficulty to ascertain the influence of methods of treatment; but if electricity is powerless to neutralize the early stages of the morbid process or prevent the spread of the paralysis, the records of experience have unmistakably demonstrated its beneficial influence in many old cases of altered nutrition of nerve and muscle.

Paraplegia, when dependent upon chronic structural disease of the cord, offers an unfavorable prognosis under any method of treatment, but both in subacute and chronic anterior polio-myelitis and ordinary myelitis the results of electrical treatment are often of the most gratifying character. Subacute and chronic polio-myelitis anterior are characterized, as a rule, by a rapid and progressive atrophic paralysis of the lower limbs, with frequent involvement of the arms. Like the acute form, the symptoms are probably due to nutritive changes of the anterior gray columns without the destructive character of the former. The degenerative reaction in the muscles soon becomes distinctly marked, associated with weakness and atrophy. The muscular atrophy occurs irregularly, but is generally widespread, certain groups of muscles being far more affected than others. In most of the subacute cases the reactions of degeneration that are observed are of the common form—*i. e.* loss of or decrease of faradic irritability, and for a considerable time increased galvanic irritability.

Erb has described a "middle" or mixed form of degenerative reaction occasionally met with, where the nerve presents normal and the muscle increased irritability. In these cases the faradic current applied to the nerve calls forth normal contractions, while the galvanic applied to the muscle indicates that the irritability of the muscular fibre is increased. When the reactions of degeneration are but partly developed, the faradic current often proves useful as a peripheral irritant, but in the most severe cases the galvanic current alone should be used, even for peripheral applications. For the most part, the current should be continuous, as in the treatment of infantile paralysis, interruptions being used only at the beginning and closing of each séance, and occasionally for prognostic data.

The spine should not be neglected in these cases, the treatment consisting of applications of the galvanic current of a strength no greater than can be readily borne by the patient. Ten or fifteen milliampères are usually sufficient, and applied through electrodes that are slowly but constantly kept in motion.

From the fact that there is an undoubted tendency in many cases of this disease toward spontaneous recovery more or less complete, it is no easy matter to determine the relative efficiency of different methods of treatment. Observations in the treatment of quite a number of cases of this character convince me that electricity not only markedly accelerates the progress toward recovery in those cases in which the tendency is in that direction, but may even turn the tide when the patient is steadily advancing toward complete helplessness. I saw in March, 1890, a male patient who verified this opinion in a most unmistakable manner. In the latter part of December, 1889, after prolonged exposure to cold and wind, the patient was confined to his bed by an attack of fever of considerable severity that lasted several days. When it subsided he experienced a feeling of heaviness in the lower limbs, although he could yet walk without great difficulty. He progressively lost power over the legs, and to a considerable extent over the arms also, without any disturbance of the sensory nerves. Muscular wasting began early in the course of the disease, and when I saw the case, three months later, the atrophy was extreme and the patient could with difficulty make his way from his chair to his bed. In testing by the faradic current, it was found that the different groups of muscles varied in the readiness of their reactions. The toes could be slightly flexed by the application of a strong current to the flexors of the legs, but application to the extensors failed to move the toes in the slightest degree. Circumstances prevented my seeing the patient again for nearly two weeks, when a second test with the same current elicited the fact that the flexors had now lost the slight irritability that was present two weeks before. Interrogation with the galvanic current showed marked changes, both quantitative and qualitative. (See *Electro-diagnosis.*) Applications of the galvanic current to both spine and the extremities were repeated nearly every day for some three months, and resulted in an approximate cure. To the spine the applications were by the labile method, and to the limbs by the stabile. Continuous currents were used, excepting when applied to the limbs, when at the end of each séance a few interruptions with reversal of the current were given.

The interesting point to be observed is that, whereas up to the date when electrical treatment was begun the symptoms were increasing in severity with steady progression, improvement was observed, if not from the first day, at least from the first week of the introduction of the galvanic treatment.

In acute myelitis electricity is contraindicated. In the subacute and chronic forms there is every probability of its aiding in recovery when there is a tendency in that direction. Erb says that there is little chance of good effect from electrical treatment apart from those forms which are restricted to the anterior gray columns and the funicu-

lar degenerations. This has not been my experience. The case which I here give is one of a number equally positive in the results of treatment that I might relate. This case was shown before the American Neurological Association, and examined by a large number of prominent neurologists, some of whom doubted the correctness of diagnosis on the ground that it was impossible, in their judgment, to obtain such results in a true case of transverse myelitis. The patient, a young girl of sixteen, was referred to me by her family physician, Dr. J. D. Farrington of New York City. Three months previously she went on a Sunday-school excursion to the seashore, and all through the day experienced more or less physical depression, and, instead of actively engaging in exercise, she sat much of the time on rocks near the water which may have been damp from the tide. Upon returning from the picnic she felt cold, and was so bent over that she could walk only with difficulty. During the night and for several days she suffered acutely, and within a week the lower limbs became completely paralyzed, as well as the sphincters of both rectum and bladder. There existed not only inability to prevent evacuation of either the bladder or rectum, but there was an absolute unconsciousness of need in that direction. She suffered, consequently, from an aggravated form of constipation and from incontinence of fæces after the aperient that was regularly required. Incontinence of urine was a constant symptom, supplemented by a severe attack of cystitis and accompanied by acute pain.

After six weeks of suffering a bed-sore made its appearance in the region of the last lumbar vertebra. It resisted all treatment, and rapidly enlarged until it was about two inches in diameter. In the early days of her illness the patient was extremely nervous and sleepless. A subcutaneous injection of morphine induced but two hours' sleep. On the second night its administration was followed by but a single hour's repose, and finally it was discontinued altogether, as it failed to induce sleep and greatly aggravated the nervousness. After two weeks of this persistent insomnia she began once more to sleep naturally. For two months she lived almost entirely on milk and champagne. When I saw the patient she was emaciated to the last degree.

Electro-muscular irritability to both currents was entirely abolished, the sphincters were paralyzed, the legs were contracted beyond the power of forcible extension, and the bed-sore was large, with a tendency to increase. The limbs were sensitive to the touch, with the paradoxical symptom of diminished sensibility when tested with the æsthesiometer. A marked perversion of sensibility was evidenced by the exceedingly disagreeable numb feeling excited by the induced current.

After seeing the case with Dr. Farrington, I agreed with him that the prognosis was most unpromising, and it was only at the urgent

solicitation of the patient's father that any further active treatment was attempted.

The faradic current had been used for several weeks previously, but, as was to be expected, without any effect whatever.

I immediately began galvanizing the legs and the lower portion of the spine, using a current strength varying from ten to twenty milli-ampères, and repeating the applications every other day. Three weeks of persistent effort failed to elicit any response in the way of muscular contractions, and the only evidence that the treatment might possibly be doing good service was the condition of the bed-sore. It began to assume a less dull and sluggish character and its periphery seemed to be contracting. At the end of the fourth week very faint muscular contractions were observed, and within another week they had so increased in vigor as to render it possible to interpret their character. They were markedly the reactions of degeneration. Those who have given much attention to these phenomena know how difficult it sometimes is to eliminate all sources of errors and to determine the exact order in which these irregular contractions occur. In this case, however, it was not so difficult as I have sometimes found it to satisfy myself on this point. The A. C. C. (anodal closure contraction) was decidedly more vigorous than the C. C. C. (cathodal closure contraction). From this time onward the patient steadily improved. The electrical reactions became quite normal, and within a month the bed-sore had entirely healed. The patient regained power over the bladder more rapidly than over the bowels, but within two months she had complete control over both fæces and urine. She was treated about four months, and at the end of that time was discharged as cured, with the exception of slight weakness in the flexor muscles of the right leg. This weakness still remains, indicating a possible irreparable damage to certain nerve-cells.

There can be little doubt that this case was in the beginning one of acute inflammation of the cord. What the exact pathological condition was in its secondary and chronic stage may be a question involving a greater difference of opinion. The tendency probably was either to degenerative softening or to atrophy of the ganglion-cells, and, to my mind, it was the second rather than the first pathological change that prevailed in this case; and that the whole transverse area of the cord was involved was evidenced by the complete abolition of both afferent and efferent nerve-function.

The practical value of this case, so far as relates to the pathological side, is in its distinct negation rather than in any affirmation. It is self-evident that, however much structural change had taken place in the way of atrophy of nerve-cells or induration or over-growth of connective tissue, the nutrition of these nerve-cells had not

been sufficiently impaired to be beyond the influence of the reparative process.

In its therapeutic aspect the lesson taught can not be too strongly emphasized. Four physicians, including myself, who had become interested in the case, regarded the condition as entirely hopeless. The father, in the face of a completely discouraging prognosis, insisted that unceasing effort should be made, and subsequently his triumphant but somewhat reproachful thought was, "What would have become of my child if I had been guided by the professional opinion so confidently expressed?"

Posterior Spinal Sclerosis (Locomotor ataxia).—This disease is frequently relieved, but never cured, by electrical treatment. Many cases of ataxia have indeed recovered, not only under electrical, but under other methods of treatment, and I myself have observed recoveries more or less complete in cases in which the symptoms, both objective and subjective, simulated the most severe forms of locomotor ataxia. In one case the symptoms were undoubtedly dependent upon a syphilitic cause. Anæsthesia was present, together with the most marked inco-ordination of movement, but under persistent antisyphilitic treatment recovery was finally complete. Profound inco-ordination of movement, with neuralgic pains and anæsthesia, may follow severe concussion of the cord, and in these cases recovery is likely to occur, and with far greater rapidity, either under general applications of the faradic current or galvanization of the spine, than if these methods are dispensed with. The discrepancies in the statements of the effect of electricity in true locomotor ataxia is due, therefore, to the fact that symptoms which are more or less transient in their nature are mistaken for symptoms which follow lesions that come on slowly after long years of incubation.

The electro-muscular contractility of ataxia is generally normal, seldom increased, and never decreased excepting when complicated with pathological changes in other parts of the cord. In regard to electrical applications, the direct treatment of the spine is perhaps the most important, and for the possible relief of any symptoms in old cases of spinal sclerosis I prefer strong ascending currents. In cases dependent on concussion, or those in which an irritative condition is believed to be present, the descending current is to be preferred. What is needed is that as strong a current as possible be passed through the cord, and so rapidly do the threads of current diverge from the seats of their recomposition that, at the best, only a slight influence can be exerted upon the substance of the cord itself. Long before the current becomes strong enough to cause any possible ill-effect on the spinal cord it causes unbearable pain in the skin under the electrodes. To get the best effects, therefore, the electrodes should be rather large and some distance apart. A stabile treatment is to be preferred, but the points

of application should be successively changed, so as to bring all the diseased part under the influence of as dense a current as possible.

General faradization is a most useful procedure for the relief of symptoms in not a few cases of locomotor ataxia. This it does by its general effects upon the periphery; and by making the applications thorough—from the head to the feet—the lightning-like pains that are so distressing are often most markedly relieved. By the use of the wire brush to the integument the sensory nerves are subjected to severe stimulation, which exerts on the cord an indirect effect of a beneficial nature.

Progressive Muscular Atrophy.—Electricity is of some value in this disease. That it sometimes arrests its progress is undoubtedly true, but it is doubtful whether it ever radically cures or *permanently* arrests it. As the nerves are unaffected, both galvanism and faradism to nerve will generally call forth reactions throughout the disease, but electrization directly to muscle shows diminished, and finally lost, contractility. The methods to be pursued in these cases are—first, the direct treatment by the galvanic current, either central galvanization or transverse conduction of the cord through the mastoid processes, supplemented by galvanization of the sympathetic and the cervical spinal cord; and, second, persistent faradization of individual muscles, by which simple and single method alone good results may follow.

Paralysis Agitans.—The treatment of many cases of this disease only confirms the statement of Erb and others of its generally incurable character. In the majority of cases, indeed, which fall under one's observation the palliation of symptoms amounts to little or nothing. When occurring in persons over fifty years of age there seems to be absolutely no hope of recovery, but in the decade between forty and fifty the results of electrical treatment are not altogether barren. In one case of exceedingly violent palsy agitans occurring in a robust man of forty-two, treatment by central galvanization and faradization of the periphery resulted in an absolute cure; and in another case, in the person of a woman of about the same age, the symptoms became through the same methods of treatment very much subdued, although recovery was never complete.

Occupation Neuroses.—Those forms of functional neuroses which have been sometimes termed professional hyperkineses have always presented on their therapeutical side a difficult problem. Writer's cramp is perhaps the most common of these neuroses, although analogous conditions relating to other occupations—telegraphy, piano-playing, type-writing, sewing, cigar-making, etc.—are frequently met with. They all "present the common feature that in certain complicated and delicate manipulations disturbances of movement occur which interfere with

the manipulation in question or render it entirely impossible." Electrical treatment in these cases, while yielding results by no means entirely satisfactory, is far from being useless.

Electrical examination indicates no special changes in the muscular reactions. Nerve-exhaustion is manifestly present, though whether mainly located in the peripheral parts or in the spinal cord, basal ganglia, or cortex of the brain, it is impossible to determine. In these cases are sometimes observed localized atrophy, neuritis, or anæsthesia, and these symptoms should receive local treatment, the faradic current being used for the first and last symptom, and the galvanic for the neuritis.

To obtain, however, the best results that electricity is capable of giving in these cases the galvanic current must be applied to the brain, the spinal cord, and the sympathetic.

The method of central galvanization, if carried out in all its fulness of detail, will answer all practical purposes. Not only writer's spasm, but the other forms of functional neuroses characterized by disturbances of movement which interfere with complicated and delicate manipulations, are treated with some success by electricity. This much, however, must be said of all spasmodic diseases: When of long standing it is difficult to do much for them, and even when relieved the symptoms are liable to recur. If recent, the symptoms, although severe, are not infrequently palliated at once by electrical treatment, and in many cases perfect recovery takes place. In all these cases rest from the occupation is imperative, for it is almost useless to attempt treatment if the patient is permitted to continue the manipulations that have caused the disease. The galvanic current is to be relied upon for the most part, and the treatment should be both central and peripheral. The faradic current, however, is by no means useless, and as a rule better results are obtained when these currents are used in alternation than by the exclusive use of galvanism. I have many times observed at least temporary alleviation of the symptoms of writer's cramp follow mild applications of a descending faradic current of tension, and in some of the fortunate cases of complete recovery the results could not, I am assured, have been so readily obtained without its aid.

Torticollis.—Torticollis, when chronic, offers a very unpromising prognosis, but in its early stages it is often cured by electrical treatment alone, and with a rapidity that leaves no doubt as to the efficacy of the remedy. I believe that no case should be abandoned until after the most thorough treatment by both the galvanic and faradic currents. Many years ago I reported a severe case of wry neck that promptly recovered under the following treatment:[1] At each sitting the muscles

[1] *A Practical Treatise on Medical and Surgical Electricity.* 6th ed. p. 494. Beard and Rockwell.

of the left side (those that were large and prominent) were submitted to mild galvanization, while the contracted sterno-cleido-mastoid muscle of the right side, toward which the head was inclined, was faradized with sufficient force to cause a relaxation of muscular fibre, allowing the head to turn gradually to its normal position. After recovery the patient had no return of the symptoms for more than ten years, but some weeks previously to the preparation of this article she, for the first time, presented herself in as bad a condition as before. The same method of treatment was adopted, and she has again recovered.

The case was undoubtedly one of true torticollis, and not simply an ordinary stiff neck, and is an important illustrative example of the value of electricity in this condition.

Angina Pectoris.—Neuralgia of the cardiac nerves yields but indifferently to any method of treatment, although both galvanization and faradization have occasionally brought about results of a palliative, and even curative, nature in cases that were thought to be incurable. The best results have followed without doubt when sensory rather than motor irritation predominated. Electricity certainly seems to exercise its best effects in those cases in which the pain is of a very positive neuralgic character, with no coexisting organic disease, although the presence of structural changes in the heart and blood-vessels does not contraindicate the judicious use of either form of current. Numerous experiments, on the contrary, go to prove that electrical applications strengthen a failing heart. Ziemssen's well-known experiments will be recalled. He found that the application of galvanic currents of considerable strength directly to the integument over the heart, the anterior wall of the thorax having been removed, influenced in a most positive manner the frequency and rhythm of the heart-beats. In the electrolytic treatment of scirrhous tumors of the breast I have had occasion many times to witness the powerful stimulating effects of the galvanic current on flagging heart-action. I was enabled on one occasion to submit these observations to a practical test in a long-standing case of angina pectoris of an incurable type. During the paroxysms of pain, which generally lasted from ten to fifteen minutes, the heart's action became exceedingly weak and the pulse barely perceptible, and on several occasions unconsciousness supervened. On the occasion of one of these attacks one electrode was applied to the cardiac region just below the left nipple, and the other over the upper dorsal vertebra. Under the influence of a continuous galvanic current thirty milliampères in strength there was an immediate change in the vigor and form of the contractions, indicating the very powerful effect exerted by the current over the motor ganglionic centres of the heart.

Among the numberless neurotic symptoms which accompany hysteria, vaso-motor disturbances are the most distressing. They seem

occasionally to take on the form of a severe attack of angina pectoris. There is cardiac pain, giddiness, pallor, faintness, and even syncope. In these cases I have often found electricity to exercise a most beneficial influence after the failure of persistent internal medication. No local treatment will serve our purpose, however, in these cases. The most thorough form of general faradization and central galvanization is called for, and meets the undoubted constitutional indications as few remedies can.

Insanity.—Every theoretical consideration, as well as the many practical illustrations of the therapeutic powers of electricity, in obscure forms of nervous diseases would suggest for it a place in the treatment of insanity. No one doubts its favorable influence over many forms of the psychoses, and yet as a remedy occupying any well-defined position in the treatment of mental disease it has not received special recognition, nor has it been subjected to any adequate test. And yet in diseases of the brain in which the mind is seriously affected there may be just as strong indications for the use of electricity as in diseases of the spinal cord that interfere with sensation and motion, or in diseases of other organs that interfere with their functional activity. In the incipient stages of mental derangement we may have to deal in many cases with simple functional disturbance, due to mild nutritive-molecular changes that elude discovery by our present methods of examination. Arndt, who has given much attention to the treatment of the psychoses by electricity, says: "Only such psychical disorders as depend upon so-called functional disturbances, or on temporary anomalous nutritive processes, or on circulatory derangements, can be cured by electrical currents; they may also be useful in deeper-seated organic changes if we seek amelioration merely. Electrical treatment is therefore specially adapted for fresh cases; rather for the milder, vague forms than for those which are characterized by violent symptoms. The faradic current simply acts as a stimulating measure; it acts successfully, especially in simple conditions of depression, whether they have developed primarily or as the result of previous violent processes. It is employed almost exclusively in cutaneous irritation of various portions of the skin; occasionally as faradization of the phrenic nerves, in order to stimulate the circulation and oxidation of the blood."

The galvanic current, however, far more frequently affords relief in cases of mental derangement than the faradic, and did space permit I could give many proofs of its efficiency. Not alone, however, should it be applied, as Arndt has suggested, to the spinal cord (and medulla oblongata), with its important vaso-motor, circulatory, and respiratory centres, but directly to the head itself. Vaso-motor disturbances are predominant in many cases of mental disease, and for their relief elec-

trical currents, so directed as to influence the upper portion of the cord and the sympathetic with its various ganglia, are strongly indicated. The most important therapeutic effects of electricity in the psychoses, however, are developed through its catalytic action on the brain itself; and to this end the galvanic current must be applied so as directly to affect the brain.

The insane suffer from nutritive changes of the nervous system almost if not quite imperceptible, as well as from the grosser anatomical lesions and degenerative processes. While electricity is quite useless in the latter condition, it ought, theoretically, to be not altogether without influence in the first, and practically it has in some cases been found to render excellent service. Just as it improves the nutrition of the muscular and peripheral nervous system, so does it favorably affect impaired nutritive conditions of the nerve-centres.

Central galvanization is undoubtedly the best method of bringing the central nervous system directly under the influence of the galvanic current. The method may be varied by galvanization of the brain, cervical sympathetic, and spine, but the method of central galvanization is easier, safer, and more effective. In cases associated with debility, and especially in those forms of insanity dependent on neurasthenia, general faradization answers a good purpose, and may with great advantage be alternated with central galvanization or localized galvanization of the nerve-centres.

More than usual care should be exercised over the dosage in the treatment of any form of mental derangement, for in these cases we meet with the extremes of tolerance and susceptibility. Some patients call for mild applications with long intervals between them, while others can bear with advantage strong and frequent applications. It is seldom necessary to apply a current strength of more than twenty milliampères, and in some cases that of five milliampères is all that will be required.

Exceptions, however, are always encountered, and I have met with cases of profound melancholia in which a current to the head of more than two or three milliampères was not only unpleasantly felt at the time, but left disagreeable sensations for some time subsequently. On the contrary, in one case of dementia with cataleptic symptoms that fell under my observation the unusual strength of thirty-five milliampères was applied to the head, not only without any present ill effects, but with undoubted good results. The interesting feature in this case, as in forms of cephalalgia to which allusion has been made, was the observation that as improvement in the mental symptoms progressed it became necessary to use a decreasing strength of current.

Nervous Dyspepsia.—I thoroughly believe in such a condition as nervous dyspepsia, and in the efficiency of electricity as a remedy for its relief. In some forms of nervous dyspepsia the food seems to be

digested in a reasonable period, but the process of digestion is always accompanied by symptoms either general or local, or both combined, that are not only disagreeable, but in some cases of a very distressing character. Whether these symptoms depend upon a simple local irritability or a disturbed condition of the entire nervous system cannot always be made out. In other forms, due perhaps to inactivity of the glands of the stomach or an impaired action of its muscular coats, the active process of digestion is seriously disturbed. For both these conditions electricity is a valuable remedy. In cases of the first type I have known central galvanization to modify very materially the symptoms. The cathode should be pressed firmly into the epigastrium, and after treating the head with the anode let it rest at the back of the neck (cilio-spinal centre), and pass a current ranging in strength from ten, and sometimes even to fifty, milliampères.

General neurasthenia is oftentimes associated in these dyspeptic cases, and therefore general faradization, while meeting the constitutional condition, often succeeds in dissipating the more local symptoms.

In cases of deficient innervation of the glands of the stomach or loss of tone of its muscular coats localized galvanization, and especially powerful applications of localized faradization, can be used with advantage.

In connection with nervous dyspepsia, and more frequently perhaps independently of it, we observe cases of atony of the stomach. Atony of the stomach cannot exist for a long time without developing into dilatation; and it is this condition of the two that we are most frequently called upon to treat. For the purpose of stimulating to contraction the muscular coats of the stomach electricity is manifestly the very best agent at our command. By stimulating contraction and relieving the dilatation we directly aid in overcoming the atony, the primary cause of all subsequent difficulty.

Although the galvanic current is recommended by some, and notably by Onimus, who gives very definite instructions as to the method to be employed, the faradic current is preferred by the majority of those who have any recorded experience. Simple external applications have proved effective in many cases. A good-sized electrode—say three inches in diameter—should be applied on the back as nearly as possible over the cardiac extremity of the stomach. The other electrode—preferably the anode—may be placed at the epigastrium, and then moved over the surface until all parts of the gastric region have been influenced. External applications are, however, frequently inefficient, and more active and direct treatment must be resorted to. Applications should be made directly to the interior of the stomach by means of olive-shaped metal electrodes. Some patients are so sensitive that it is almost impossible to pass the instrument, but when there is tolerance the treatment becomes a very simple matter.

Nervous Asthma.—Ordinarily, perhaps, asthma cannot be classed as a purely nervous affection, but there are, I am persuaded, many cases which are of neurotic origin, and which indicate this origin by the readiness with which the symptoms are allayed by electrical treatment. Taking the cases of asthma as they successively come under our observation, the majority undoubtedly fail to receive any marked benefit from either the galvanic or faradic treatment, and for this reason it has been asserted that no good ever comes from such methods. My experience has been far from sustaining this opinion, for in a certain proportion of any given number of cases I have always found more or less benefit to accrue, more especially from applications of the galvanic current. The difficulty in most cases is in the use of too weak currents.

It should always be remembered that the most efficient action of electricity is at the points of the recomposition of the current—*i. e.* immediately underneath the electrodes; that the threads of current diverge widely and abruptly, and in order to submit the deeper-seated tissues to catalytic influences of any force the external applications must be proportionately strong. Many who have used electricity for years are surprised when told that currents of forty milliampères have been sometimes used to the head, and even sixty and seventy milliampères in applications to the neck.

Everything depends upon the size and adaptation of the electrodes, and when these are properly adjusted, and the current increased gradually and without interruptions, the difficulty of applying currents of sufficient strength readily resolves itself. While my experience teaches me that strong currents are, as a rule, indicated in asthmatic cases, and that we shall fail generally to distinguish between the relievable and unrelievable forms if the treatment is not vigorously attempted, cases are occasionally met with which yield fair results under milder applications. In the case of a little boy aged thirteen lately under my care apparent recovery took place under the persistent use of a current-strength not exceeding ten milliampères. The usual position of the anode in this case was at the inner border of the lower portion of the sterno-cleido-mastoid muscle, and of the cathode on the extreme upper portion of the spine. Toward the close of each attack a copious expectoration of a substance much resembling boiled rice or starch took place, quickly followed by complete relief. The interesting observation in connection with the application of the electricity was, that the treatment, when attempted at the beginning of an attack, invariably cut it short and hastened the inevitable mucous discharge.

Even the faradic current affords relief at times. On the theory that asthma is associated with nerve-irritation in the upper part of the respiratory tract, both Schaeffer and Brisgen have applied the faradic

current vigorously in many cases, with the electrodes below the angle of the jaw. They claim to have cured several cases in this way.

Anæsthesia.—Although anæsthesia is intimately related to paralysis, and is due to many different causes of a grave organic character, it is, on the other hand, a symptom to be classed very frequently with the functional neuroses, and as such is often relieved by electrical applications with rapidity and completeness. Every one who has treated many cases of paralysis, ataxia, etc. is fully aware of the temporary relief sometimes given to sensory symptoms by peripheral stimulation, but it is chiefly in the so-called "conduction anæsthesia" that electrical treatment is indicated for its curative influence. In neurasthenic and hysterical cases, and in some cases of poisoning, the persistent anæsthetic symptoms that exist depend, very likely, upon lesions too fine for detection, but which readily vanish before the nutritive improvement brought about by both direct and peripheral stimulation. No other cutaneous irritant can for a moment be compared to electricity for vigorous action and harmless effect. With the electric brush such strong impressions can be made as to influence most powerfully, by reflex action, the peripheral paths of conduction as well as more central parts, and yet in no way affect the structural integrity of the integument.

The object, therefore, of electricity in anæsthesia, and which it accomplishes in an unique way, is "the removal of any affection which inhibits conduction, exaltation of the excitability of the receptive organs, the removal of obstacles to sensory conduction itself, and finally the removal of secondary nutritive disturbances which may be present and interfere with the conductibility of the sensory apparatus."

In some cases of anæsthesia associated with a neurasthenic or an hysterical condition the effects of a local electrical stimulation are not limited to the part irritated. Remote portions of the surface of the body that have been anæsthetic for a long time show a restoration of sensibility, temporary or permanent, and especially have I observed a return of sensation to the mucous membrane of the lips and mouth following brisk external stimulation of the cheek. In anæsthesia dependent upon vaso-motor disturbances more direct applications to the central nervous system, and especially to the sympathetic system, will be found necessary. Associated with anæsthesia (or perhaps it might more truly be said that anæsthesia is itself the associated symptom) is a condition of cutaneous angio-spasm. In the cases of this character that have fallen under my observation perfect whiteness of the skin has been the most prominent symptom. Associated with this pallor we often find pain and a considerable degree of numbness, and, if the difficulty is in the fingers, as is usually the case, decided impairment of their flexibility.

These are the very cases in which, on physiological grounds, electricity would seem to be strongly indicated, and yet in a number of cases treated the results were almost nil. When the disorder is located on the trunk rather than in the extremities, the prognosis would seem to be somewhat more favorable. The liver is believed to be at fault in these cases, and under treatment directed both to the skin and the organ itself we may hope to relieve the condition.

Impotency.—Lost or impaired sexual power may be benefited by electrical treatment, but the application must be administered with judgment and with the understanding that a large proportion of cases will resist every method of treatment. One of the greatest mistakes in applying electricity is the use of currents of too great power; and it is not too much to say that many cases have been permanently injured by strong and prolonged applications of both the galvanic and faradic currents. One is the more likely to be led into this error of too vigorous treatment from the fact that of all parts of the body those portions in the vicinity of the sexual organs, where the electrodes are most frequently applied, feel the electricity least. Impotence, again, is most capricious in the readiness with which it responds to electricity. If it were possible to determine with any accuracy the kind of cases that would be benefited by electricity, it would be a great point gained and save much time and expense to the patient. It seems, however, almost impossible to determine this, and in an experience of twenty years, and in the treatment of hundreds of cases of sexual neurasthenia, I find it impossible in the initial stages of any individual case to offer a confident prognosis. But this much can be positively affirmed: Electricity intelligently used will do more for impotent conditions than any other method of treatment, and, in my opinion, of all others combined, and therefore frequently succeeds after complete failure following persistent efforts along other lines.

In a general way it may perhaps be said that the symptomatic and organic forms of impotence respond with least readiness, and the atonic and psychical varieties most readily, to treatment. The treatment of impotence may be either general or local, or a combination of both methods. In neurasthenic cases both general faradization and central galvanization are of great value, and by their general toning effect upon the nervous system sometimes help these cases without the intervention of local treatment.

The treatment of impotence by local electrical methods is variable, and if internal applications are made the faradic current is to be preferred. Using insulated electrodes, one pole may be placed in the rectum and the other in the urethra. Currents of quantity from short, thick coils of wire are greatly to be preferred for internal treatment, but as these currents of quantity act with extraordinary vigor when applied

directly to the mucous membrane of the urethra and rectum, the utmost caution must be exercised in their use. With one insulated electrode in the rectum and the other externally at the perineum or between the penis and scrotum, very much stronger currents can be used; and the same may be said if one pole is connected with an uninsulated sound in the urethra and the other on the thigh or spine. Purely external applications, one electrode pressed firmly on the scrotum, the other on the spine over the genito-spinal centre, or one on the perineum and the other on the back of the neck, are simple methods of application that not infrequently afford good results. In external applications currents of tension from long and thin coils of wire are mainly indicated.

Drawing off sparks from the spine and from the genital regions by statical electricity is another valuable method. The use of statical electricity is necessarily more than local in its effects, and is really a form of general electrization, but it is especially felt at or near where the sparks are drawn, and by this method very powerful local impressions may be made. In using any form of electricity we have to guard against too long, too strong, and too frequent applications; but we are not to be alarmed if a drop of blood should appear after an internal application, and we are always to abandon, suspend, or modify the applications when they seem to disagree.

On the whole, the faradic current of quantity is, as a rule, to be preferred to the galvanic, although the latter, through its influence over the excitability of the genito-spinal centre and over the tonicity of the arterioles of the erectile tissues, is often indispensable in the treatment.

Neuroses of the Nerves of Special Sense.—Tinnitus aurium is one of the most distressing of the diseases that affect the ear, as well as one of the most difficult of the aural symptoms with which the otologist has to deal. In the galvanic current we have at our command an agent invaluable for diagnostic purposes, and possessing a limited though positive therapeutic value. If the morbid subjective noises are of nervous origin, we may hope for a cure, or at least for an amelioration of the symptoms, through the galvanic current. The healthy auditory nerve reacts in a certain definite way to the galvanic stimulus, but in pathological conditions these reactions are variously changed. The subject of auditory reactions to the galvanic current is, however, too extensive to be discussed here, and the reader must be referred to special treatises. It may be said, however, that the difficulties in the practical application of this method of electro-diagnosis are very great. The normal formula can be obtained only in a certain proportion of cases, and oftentimes only by painful currents; and it must be confessed, even when we obtain apparent deviations from the normal formula, we are not always sure just what such deviation indicates, either

in special pathology or in therapeutics. When the galvanic current (negative pole) is applied to the external auditory canal, certain sounds are excited by the interruption of the current, and especially by its closing, which vary with the strength and continuance of the current and with the individual; yet in the healthy ear the polar effects are never always the same. With the closing of the positive pole, however, there is never any sensation of sound, except in pathological conditions. The polar effect is therefore the leading effect, and the direction of the current through the auditory nerve appears to have no demonstrable influence.

If, when the anode is applied to the external auditory canal in any case of tinnitus aurium, and the current is closed, we obtain a distinct reaction, the probabilities are that the symptom is of nervous origin. On the other hand, if the galvanic excitability of the nerve shows no anomaly, it is probable that the symptom does not arise from a purely nervous cause. In the few instances that have come under my observation when treatment has benefited these cases I have always been able to get distinct anodal reactions.

Impairments of the senses of taste and smell ordinarily recover in time, but we do occasionally meet with cases of complete ageusis and anosmia which persist long after the disappearance of the exciting cause. Influenza is a frequent cause of temporary disturbance of these functions, and the following case is such an excellent illustration of the more persistent character of the symptoms following influenza, and the influence of the galvanic current in relieving them, that it is worthy of record: The case was that of a young lady whose sense of taste had been so completely lost for ten months that it made no difference to her whether she partook of what was most bitter and disagreeable or of the most attractive and delicately flavored dishes. In January of the previous year the patient suffered from a sudden and severe attack of influenza, followed by fever. In March a sudden attack came on, resulting not only in a loss of the sense of taste, but also in the loss of the sense of smell. It was evident that all the gustatory fibres were involved, for, however completely the various portions of the tongue and surrounding mucous surfaces were tested, it was impossible to elicit the slightest suggestion of the existence of this special function. To the influence of the galvanic current the vital function of the nerve responded but faintly—so faintly indeed that it was hardly recognizable to the sense of the patient. After two or three applications, however, the metallic taste was very quickly and distinctly appreciated, and in about two weeks the lost function was quickly and permanently restored.

Diseases of the Skin.—Dermatological diseases, so far as they are amenable to the therapeutics of electricity, may properly be regarded as of nervous origin. Certain it is that diseases of the skin, taking

the cases as we find them, are not readily amenable to electricity, and yet that many cases are greatly and quickly benefited by this treatment is within the experience of every one who has made much use of the current for this purpose. Both forms of dynamic electricity exert a more or less favorable influence in skin affections of the nervous type, but the galvanic is greatly to be preferred. The superiority of galvanization over faradization lies in the fact that the former alone exerts the necessary electrolytic influence, and influences far more powerfully than the faradic the central nervous system. Central galvanization alone not infrequently proves of great service in some skin diseases—in prurigo and chronic eczema especially. This method of treatment alone, without local applications, electrical or otherwise, has undoubtedly been the means of curing some and relieving other cases of long-standing eczema. In other cases, however, it is impossible to dispense with applications directly to the diseased surface. An adjustable electrode, preferably the anode, two or three inches in diameter, may be placed over the trunk of the nerve the branches of which supply the area mostly affected, while the cathode should be applied directly to the diseased surface.

How much advantage is possessed by this method over the method of applying both electrodes directly to the diseased parts I am not prepared to say. I have seen good results quickly follow both kinds of application, but whichever method is adopted, it is to be borne in mind that the cathode, from its more vigorous and distinctive electrolytic properties, is generally to be preferred for local effect. The electric brush with the faradic current is a not unimportant procedure in some conditions. It is more or less painful, and is chiefly indicated in cases in which there is profound itching irritation, where I have often found it far more efficient than ordinary electrodes. Applications which in health would be absolutely unendurable, are in some cases of eczema positively agreeable. Some cases of severe itching also are temporarily as well as permanently relieved in this way, although local applications of the galvanic current usually afford better results.

My own personal experience has been most satisfactory in the treatment of herpes zoster by the galvanic current, whether its seat be the head, trunk, or extremities. Where there is a rheumatic or neuralgic diathesis we are liable to have herpes, and indeed any cause, probably, which weakens the vigor of a nerve-trunk or its cutaneous branches may be followed by the characteristic pains of this disease. Both currents, the galvanic and faradic, are likely to do good when the pain is confined to the trunk or the extremities, although the former is the most efficient.

In herpes frontalis, however, my experience in a considerable number of cases convinces me that the galvanic current alone can be relied

upon to give relief. Perhaps if it were possible to apply the faradic current with the same strength that it is applied to other portions of the body, it would be of the same service. It is impossible to do this, for the head is so extremely sensitive to the induced current that only the very mildest applications can be given. Besides relieving the pain of herpes, electricity undoubtedly somewhat shortens the acute stage, and by breaking the force of the disease tends to modify the scarring.

Nervous Diseases of the Larynx.—From the absence of all inflammatory action and the readiness of their recovery under electricity we are justified in regarding a considerable number of cases of aphonia as of nervous origin of a functional character. Bilateral paralysis of adductor muscles acting upon the vocal cords is regarded as most frequently associated with aphonia dependent upon hysteria and debility. In these cases electricity does much good, both through general and local treatment. Simple external treatment is often very efficacious in aphonia, and the faradic current in these hysterical and nervous cases is quite as beneficial as, if not more so than, the galvanic.

In cases, however, which resist external applications the electrodes should be applied directly to the vocal cords. The electrode should be kept in the larynx for three or four seconds and a succession of short rapid shocks passed from the interior to the exterior. In the internal treatment as in the external both currents have been used with success, but the faradic current is quite as efficient as the galvanic, and is perhaps to be preferred.

Nervous cough is another symptom which has often yielded to local and central applications of the galvanic current.

Electricity in Gynecology.

Until a recent period the advances in the therapeutic uses of electricity were more especially along the line of those distinctively nervous affections that were neither specific nor structural in their nature. Cases of this latter type have always yielded but meagre results under electrical treatment, and I do not know that any competent authority seriously claims for electricity in most cases of structural disease of the central or peripheral nervous system more than temporary and palliative effects. And yet those who, arguing on the side of their prejudices or out of the fulness of their ignorance of the subject, ascribe to electricity a very low place in therapeutics do so mainly on the basis of its failure to cure a class of conditions incurable by any method of treatment. The statement that as a therapeutic agent "the effects of electricity are limited" must indeed seem a rash observation to those who have repeated evidence of the wide range of its influence in the relief of nervous symptoms, and especially so to those who have witnessed the really remarkable relief so often afforded by both extra- and intra-uterine

applications of the galvanic current. When a man possessed of the experience of Keith of Edinburgh can say that many are prejudiced against electricity because they consider it quackery, and know nothing about it; that his confidence in its power to relieve disturbing symptoms of fibroid tumors and to cure many chronic inflammatory conditions of the pelvis continues to increase; and that he has no fears for the future of electricity,—we have testimony that must greatly outweigh assertions and opinions that are purely negative. In a recent and animated discussion of the subject at the Société de Chirurgie of Paris equally favorable opinions were advocated by the majority of those engaged in the debate, and the strength of these opinions was accentuated by the fact that the majority of those who hold them are signally distinguished as laparotomists.

Static electricity has a limited range of usefulness in diseases of women compared with the two forms of dynamic electricity. By the ordinary methods of its application it acts as a stimulant and tonic, and is therefore of service in amenorrhœa and in the various constitutional disturbances so generally associated with uterine disease. In dealing with the other two forms of electricity I do not propose so much to give the results of my own experience in gynecological electro-therapeutics as to allude briefly to some points in the rationale of its effects, and to offer some practical observations on the methods to be employed.

The effects of the faradic current are mainly mechanical, and according to the construction of the helix and the length and thickness of the wire do we measure its action on the muscular tissues of the uterus. Applied directly to the uterus of animals in physiological experiments, the organ visibly contracts, although not to such an extent as do the intestines, which on application of the electrodes can be seen to draw up gradually very much after the manner of a woman's work-bag. Its action on the smooth muscular fibres of the human uterus when applied therapeutically is analogous to that of ergot, although manifestly more prompt and energetic, especially under the influence of the positive pole, which possesses a much greater power over the involuntary muscles than the negative. It is a current of alternation, of constant closing and breaking, hence it produces a sort of interstitial massage, heightening the activity of the circulation, accelerating absorptive processes, and influencing favorably the nutrition of parts.

Faradization by its power over muscular contractions sensibly increases temperature. According to the chemistry of the development of heat during muscular contractions, muscular work is the result of the decomposition of nitrogenous substances, and the muscles grow at the same time that they work and develop heat. That the value of the faradic current is more limited than the galvanic in the treatment of uterine disease must be immediately manifest to all who appreciate

the difference between them, but in some conditions which come within the range of its physical and physiological activities the faradic current may exceed in efficiency the galvanic. By its direct excitation of the smooth muscular fibres of the uterus we are enabled to combat that stasis of the circulation which is the beginning of uterine inflammation.

By this method we obtain a veritable interstitial massage that is potent in overcoming the primary inertia of the organ, and in preventing an arrest of retrograde metamorphosis, through which comes subinvolution with its inevitable and persistent sequelæ. In its purely local influence, then, faradization would seem to be preventive rather than curative as it relates to uterine disease; or, rather, it is preventive so far as concerns the later condition of uterine engorgement, and curative only in its initial stage. When the processes that go to make up the graver and more chronic diseases of the uterine parenchyma and its lining membrane have continued a long time, as is usually the case when medical interference is sought, the simple mechanical effects of the faradic current would be altogether misdirected.

Here we resort to the electrolytic influence of the galvanic current, or rather to what may be more fitly termed its galvano-chemical cauterizing effects, through which are destroyed the granulations and fungoid growths of the diseased mucous membrane. By the interpolar influence of the current we correct a languid nutrition and hasten the absorption of exudations.

In considering the many excellent and curative effects of internal applications of the faradic current we should not lose sight of the fact that external applications alone are frequently most efficient methods, especially for the relief of the disorders of menstruation. When we remember that in young girls it is neither desirable, nor in many cases possible, to administer internal treatment, the importance of having at command external methods that may prove serviceable is readily appreciated. Electricity is not merely a stimulant, but may be made to act as a powerful constitutional tonic. Under certain conditions its action also is sedative, and these effects of sedation and improvement in nutrition are far more important than its stimulating effects. As in many of the diseases peculiar to women, it is of prime importance to improve both the local and general nutrition and to produce not only stimulating but sedative effects, the method of general faradization plays no unimportant part in the treatment of diseases of women, and especially, for reasons just stated, in the treatment of the disorders of menstruation occurring in young girls.

Electricity is no exception to the general law that in order to obtain the constitutional tonic effects of a remedy the whole system must be brought under its influence. It is not a whit more irrational to expect one to appreciate the full tonic effects of cold water by washing one

arm only than it is to expect the full effects of electricity by using it locally. Experience here confirms analogy, and teaches that the constitutional effects of electricity can only be obtained by making the applications all over the person and to the central nervous system.

The results of these methods are variously modified according to the conditions of disease or special idiosyncrasies of the patient. Many, and perhaps the majority of, patients subjected to thorough general applications experience a feeling of enlivenment and exhilaration. In others the tendency may be to sleep, and in such cases the patient should be permitted, and even enjoined, to quietly repose for some time. Because of this disposition to sleep which is so often observed it becomes in many cases desirable, especially when insomnia is present, to administer the applications at night before retiring. The relief from indefinable nervous pains and from general and local weariness is a very agreeable temporary effect of general faradization. Sometimes this feeling of relief lasts for several hours, and at other times for a much shorter period, but in either case persistent effort will, as a rule, result in more or less permanent benefit.

Now, in those cases of amenorrhœa, dysmenorrhœa, or menorrhagia where it is impracticable to attempt internal methods of treatment we can with confidence offer a favorable prognosis only on the assumption that no serious pathological condition prevails, and in the vast majority of cases of amenorrhœa occurring in young girls it is not at all probable that any such important pathological condition exists. Most of these cases are probably associated with, and more or less dependent upon, chlorosis or nervous exhaustion, and the important thing is not to specially stimulate the uterus, but to change the constitutional condition which is the cause of the suppression of the function. Accordingly, the treatment by general faradization, combined with such internal medication as may be specially called for, is generally sufficient without applications directly to the uterus. Indeed, the majority of cases of functional disease of the uterine organs require general as well as localized electrization.

In any case of amenorrhœa where the patient is weak and anæmic, with other and well-understood evidences of malnutrition, the faradic current is strongly indicated over the galvanic. As already stated, the applications should be general, although the local treatment, when permissible, is always in order and undoubtedly hastens the desired effect. Localized galvanization is, as a rule, not only not indicated in such a condition, but in many cases, as I have had abundant occasion to observe, tends to induce a condition of nervous irritation that is exceedingly unpleasant. In amenorrhœa either pole when applied to the uterus may be followed by the best results. The negative, in the subjective sensations that it causes, is the stronger, but the positive is decidedly prefer-

able in some cases, because its tendency is to more readily contract the involuntary muscular fibre. In the treatment of neuralgic dysmenorrhœa, where the faradic current is sometimes of value, the positive pole locally applied is undoubtedly preferable. On physiological grounds alone this conclusion might readily enough be reached, but unfortunately electro-physiology is as yet but a very uncertain guide in many cases. I have therefore for years carefully observed and as carefully recorded the differential effects of the poles in this condition, and have become convinced that the average results are superior when the positive pole is used.

On the same principle that we use general faradization in cases of amenorrhœa associated with, and perhaps dependent upon, a weak, chlorotic condition of system, we make applications of it where similar symptoms are associated in the menorrhagic subject. In not a few such cases I have known simple external treatment by this method to be followed by complete and permanent cessation of the excessive flow, and a corresponding improvement in appearance and strength.

The local treatment of the uterus and its appendages may be either external or internal. The external treatment consists simply in placing one pole in front, over some portion of the abdomen, according to the indications of the case, and the other over the lower lumbar region. This method is frequently of great service in the disorders of menstruation, and in the case of virgins should certainly be attempted before resorting to the internal method.

The localization of the current in the organ in this way is, of course, only partial, and far less effective than internal applications; while the benefit derived is undoubtedly in part due to the effects of the current, at least of the galvanic current, on the lower part of the spinal cord and the abdominal ganglia of the sympathetic.

The internal treatment of the uterus and ovaries by the faradic current may be effected in two special ways. 1st. By the uni-polar method. The internal electrode may be applied either to the cervix uteri, to the interior of the uterus, or in the rectum, while the other is applied externally, either at the nape of the neck, near the sixth cervical vertebra, over the lumbar region, or, as is most generally the case, over the abdomen. Applications to the cervix are made by means of an insulated electrode with a metallic bulb, or, instead of the bulb, small plates may be used to clasp the os. The vagina may be treated by a straight or slightly curvèd metal electrode. It is an interesting and important fact to be borne in mind that internal are relatively far less painful than external applications. Very many, therefore, in first attempting this method of treatment are surprised that the sensations under the broad surface of the external electrode are complained of more than those at the point of contact of the small internal electrode.

In uterine displacements the faradic current by the uni-polar method has accomplished some good. The rationale for its use is indeed so clear that from the standpoint of theoretical considerations alone one might be pardoned for regarding it as almost a specific in this class of cases. The two most important factors that make up the value of electrical applications in displacements are probably the hyperæmia, and especially the contraction of muscular fibre, that follow its use; and as the contraction of a muscle determines the amount of its nutrition, it follows that if a current of electricity is localized in a given point of the uterus, that part will contract, its nutrition be improved, and at the same time counteract any flexion in the opposite direction. It must be confessed, however, that even in experienced and competent hands the results of electrical treatment in this special field have not equalled the brilliant promises of some of its ardent advocates.

The simplest, and probably least efficacious, method is to introduce one electrode behind the os uteri, while the other is applied externally over either the pubes or sacrum. A more effective localization of the current is accomplished by introducing one electrode into the uterus, while the other is placed externally; but more effective than this is the internal use of both poles, still by the uni-polar method. In cases of anteflexion one pole, the curve of its stem corresponding to that of the sacrum, is introduced into the rectum up to the point nearest the posterior wall of the uterus. In this way the current is quite accurately localized in the posterior uterine wall, causing contraction and improving nutrition. In retroflexion the first electrode, instead of being passed into the rectum, is introduced into the bladder and applied to the anterior wall of the uterus. When the faradic current is used—and this form is chiefly indicated—the relative position of the two poles would seem to be of no special importance, although for the intra-uterine electrode the anode may be preferred, on the theory that it has a greater power over unstriped muscular fibre. Tripier, however, recommends that the negative pole be placed in the uterus. The pain is sometimes considerable, and is due to two causes: first, the concentrated action of the electricity on the mucous membrane; second, the contraction of the uterine fibres. In other cases very little discomfort is produced. By beginning with a very weak current and gradually increasing it, a much greater strength can be endured than if this precaution is not observed. In this connection it may be pertinent to the subject to say that when voluntary muscles are subjected to the action of the poles of either a galvanic or an electro-magnetic battery, contractions instantly occur. These contractions continue, as is well known, during the passage of the faradic current, but quickly relax after the first shock of the galvanic. When, on the contrary, involuntary muscular fibre, of which the uterus is composed, is subjected to

the influence of the electric current, movements are not induced until a certain time after the tissues have been acted upon. The movements thus excited continue for a time after the cessation of the current, and do not, as in the case of voluntary muscles, cease as soon as the electrodes are removed. The most efficient action, however, of the faradic current upon the uterine tissue is through what is known as the bi-polar method. In this method both poles, the positive and negative, are combined in a single electrode, constructed either for intra-vaginal or intra-uterine applications.

The physiological and therapeutical effects of the faradic current vary greatly according to the construction of the helix, and many of the machines that are sold for medical purposes are of limited value. The galvanic current, on the contrary, varies but little in its sensible effects whatever form of battery is used, and in the selection of an apparatus the question is not as to the character of the current, but relates more to matters of convenience and constancy. The two forms of faradic apparatus in general use are what are termed the separate and the continuous coil. The separate-coil apparatus is almost universally composed of only two distinct coils, the primary and the secondary, although those who use electricity to any great extent in gynecology utilize a third coil of exceedingly long and fine wire. The primary coil, with its short, thick wire, gives a current of exceedingly low tension, but of considerable quantity, while the longer and thinner the wires, up to a certain point, the greater the tension and the less the quantity.

Externally used in the ordinary methods of electrization, the currents of quantity produce little if any effect. Their tension is so low that it is with difficulty that the current can force its way through the great resistance of the skin. The currents of tension, on the contrary, readily overcome the resistance of the skin, and are adapted for all external treatment. When, however, we apply the currents internally, even by the uni-polar method, a very great change is observed in the efficiency of the currents of tension and of quantity. The former, even if used with all the power that an ordinary battery is capable of giving, seldom causes pain or very violent contractions, and after a few moments of application absolutely no sensation may be experienced, and both physician and patient may be in doubt whether any electrical action is taking place. Just as the current of tension acts with apparently decreased vigor when applied to the vagina, uterus, and other internal parts of the body, the currents of quantity seem to double their energy and to produce both sensation and contraction of a very positive character. Substitute for uni-polar the bi-polar method, and the contrast is far greater. A current of quantity which when applied externally makes absolutely no impression, and even when applied internally by the uni-polar

method is felt with little vigor, causes, when passed through the poles of a bi-polar electrode, the most vigorous contractions and positive sensations. The continuous-coil apparatus, in that it affords a wider range of electrical effects with its four distinct qualities of current of quantity and tension, is to be preferred in gynecology as well as for general therapeutic purposes.

These currents of quantity, when applied internally through a bi-polar electrode, should be used with caution. The extraordinary vigor with which they act upon the vagina, uterus, rectum, or bladder, compared with the exceeding mildness of their action when applied externally, will hardly be credited without actual demonstration of the fact.

The physiological effects of the current of quantity indicate in a measure what its therapeutical effects should be, and also the pathological conditions for which it should be used. Primarily, it is a powerful stimulant and tonic for muscular fibre, and when there is defective muscular contraction it is often used with the most marked success. In post-partum hæmorrhage it is invaluable, and has the advantage over ergot that it acts simultaneously and can be readily graduated, so that the power put forth shall be just sufficient to accomplish the object sought. It is in the beginnings of uterine disease that the faradic current is especially valuable, and if used promptly and judiciously after confinements and abortions when subinvolution is threatened it will prevent much subsequent trouble. "We no longer ignore the fact to-day that the great majority of uterine inflammations, probably of septic origin, are due most frequently to an arrest of the retrograde metamorphosis of the uterus, that they are created entirely by uterine subinvolution, and that the circulatory troubles, characterized by congestion and stasis, preside over their initial evolution. If the physician interferes, then, by removing obstruction and sepsis at the same time, producing a passing hyperæmia, a sort of circulatory drainage, if he combats the primary inertia of this organ, the slowness of the circulation of which gives rise to all the subsequent inflammation, he puts in an excellent treatment which prevents and cures at the same time. Such is the rôle of faradization, which, applied in the uterus in the proper manner, preceded and followed by an antiseptic injection, produces a sort of interstitial massage, provokes the contraction of all the smooth muscular fibres, excites and hurries the circulation, accelerates the absorption of exudations, and so corrects a languid or perverted nutrition."[1]

In fully-developed subinvolution the benefit that follows bi-polar faradization with the current of quantity has, in my own experience, been positively and promptly indicated. The current of tension from the long, thin wire of the helix possesses an altogether different func-

[1] *Chronic Metritis*, by George Apostoli, translated by A. Lapthorn Smith.

tion. It possesses but a limited influence over the contractions of the uterine tissues, and is manifestly inferior to the current of quantity in its influence over the circulation. It affects the nervous system powerfully, however, and possesses an influence over pain that is in some instances little less than magical. The best results that are obtained in uterine and ovarian pain undoubtedly occur in cases unassociated with organic lesions. In these cases the relief is often prompt and permanent, but even in severe forms of pain dependent on or associated with structural uterine disease, the relief afforded is often very great. In cases of ovarian pain it is manifestly impossible in many cases to say whether the ovaries themselves are diseased or not, and it is most unfortunate that they should ever be removed without first testing the efficacy of either the galvanic or the faradic current of tension, both of which play such an important rôle in the relief of pain. It is within my own experience that after both ovaries had been removed for the relief of ovarian pain, but without avail, the galvanic current succeeded in effecting a complete and permanent cure.

Valuable as is the faradic current to prevent, and even cure, uterine and ovarian disease, it occupies in many respects a quite different field from that of its fellow, the galvanic current. In the use of the first named we depend mainly upon simple mechanical and stimulating influences, while in the use of the other we rely upon its electrolytic influences, or rather on what may be more fitly termed its galvano-chemical cauterizing effect, through which are destroyed the granulations and fungoid growths of the diseased uterine mucous membrane. Just as the positive pole of the faradic current has an action of its own superior in effect to the negative in causing uterine contractions, so the positive pole of the galvanic current has an action peculiar to itself. Here oxygen is generated and acids accumulate, which render this pole directly hæmostatic. It is therefore indicated in all hæmorrhagic conditions, as well as where there exists an excess of the natural secretions. Owing, also, to the greater retractibility of cicatrices following positive galvano-cauterization, the results are more lasting in the treatment of fungoid growths or vegetations than could possibly be the case with the negative pole.

At the negative pole, on the contrary, the alkalies precipitate, imparting caustic properties and causing effects fluidifying rather than hæmostatic. The absorptive process is undoubtedly more active under this pole than under the positive, and is especially indicated in indurated chronic metritis and for the resolution of fibroids.

That the galvanic current often completely dissipates fibroid tumors of the uterus few will, I believe, affirm. In the treatment of scores of fibroids on the external surface of the body I have never yet seen a single instance where one of them completely disappeared. As a rule,

the reduction is comparatively slight, unless suppuration is excited, which may be easily done. External fibroids are simply unsightly, and for this reason we desire to be rid of them, and as it is not possible to obtain more than a reduction in size, the knife is to be preferred and electrolysis has fallen into disuse. We treat uterine fibroids, on the contrary, not because they are unsightly, but because associated with them are a train of symptoms sometimes of the most distressing character. These symptoms can, it is believed, be relieved to a greater or less extent by electrolysis, and sometimes so completely relieved as to lead to the belief, so far as the patient is concerned, that the tumor has entirely disappeared. In the great majority of cases, however, it is simply a symptomatic cure. The tumor is still there, but reduced in size, and so far as pressure upon surrounding parts is concerned, or any hæmorrhagic tendency, is entirely harmless. I am a firm believer in the great utility of the galvanic current in the thickenings and infiltrations resulting from inflammation of the pelvic cellular tissue. For the absorption of old exudations in other parts of the body this treatment has long been used with excellent results, and in pelvic exudations the results are even better. I have seen the treatment, persistently carried out, result not only in the absorption of large pelvic deposits, but in the cure of the most obstinate and severe sciatica and in the restoration of power to partially paralyzed limbs. In such cases both sciatica and paralysis are caused, undoubtedly, by pressure upon the pelvic floor, and can be relieved only through the dissipation of the morbid products.

There are two methods of action through which we obtain results from electrolysis. The first and most apparent is the absolute destruction of tissue which takes place at the time of treatment. Some suppuration may follow, and thus, by an actual loss of substance apparent to the sight, the tumor decreases in size. If, however, these were the only active forces in the electrolytic process, the method would lose much of its effectiveness.

If this be not so, how can we account for the many well-attested cases where morbid growths have entirely disappeared under simple external applications? Herein is the difference between the electrolysis of organic and inorganic substances. In the electrolysis of inorganic substances the effects cease as soon as the current ceases, the substances remaining in the condition that the current left them. The electrolysis of organic substances, on the contrary, starts a process that continues long after the current ceases to flow. Besides this subsequent effect, the current penetrates the tissue and induces various important changes beyond and beneath the eschar, and these combined agencies do far more, in many cases, to diminish the size of morbid growths and prevent further development than an actual destruction of a limited area.

The methods and technique of gynecological electro-therapeutics have been only recently developed and are still developing. Most extravagant and unreasonable estimates of its efficiency have been held by the more enthusiastic, while the extreme conservatism of many eminent gynecologists would relegate it to a comparatively unimportant position in the treatment of uterine and ovarian disease. Adverse opinions upon this interesting subject, when based upon thorough and well-directed experience, are of value and altogether indispensable; but when there is no experience behind opinion, or an experience that has been guided by no clear insight into the law of physics and technique of methods, opinions, either for or against, are manifestly worthless.

Thus would I estimate the opinion of men, otherwise most competent in the line of gynecological work, who discourage the use of electricity by the newer methods for the relief of conditions in which the curette or knife alone were formerly supposed to be efficient. These newer methods, first introduced, as is well known, by Apostoli, are special and unique, and ignorance in their use must account in some measure for the failures to obtain the usual results, and necessitates a brief physical introduction and a description of apparatus and secondary appliances essential to conduct experiments in this direction.

1. *The Battery.*—At the outset let it be understood that so far as the physical and physiological and chemical effects of the galvanic current are concerned it is immaterial what form or size of cell is used. In view of the discussions that even now arise in medical societies, among men who are supposed to be proficient in regard to this subject, concerning the superiority of the effects of this or that element, this statement is a pertinent one. No matter what the origin of the galvanic current—whether from large or small cells, from the voltaic pile or from the huge dynamo with which our streets are lighted—the kind of work is always the same according to the electro-motive force and the resistance in the circuit. Electro-motive force is one, and Ohm's law is our only and infallible guide, and attempts to prove the superiority of this or that kind of element, except on the ground of constancy or convenience, is useless. While this is true of the galvanic current, it is by no means so with the faradic, the causes of which will be found explained in the previous pages of[1] this article. To do thorough satisfactory work with electricity in gynecology the practitioner should have at command an electro-motive force of about seventy-five volts. He can do with less than this in most cases, but occasions occur when the whole number will be required. As constancy is a very essential point in the treatment of this class of cases, the ordinary single-fluid cells should not be selected. As they have but little internal resistance and a fair electro-motive force, it might be supposed that they would answer

[1] See p. 138.

every purpose; but as they have no satisfactory provision for depolarization, the hydrogen that collects upon the plates soon lessens the current to the detriment of the treatment. For constancy the Daniels is the ideal cell. It gives an electro-motive force of one volt, and even when short circuited will retain its constancy for a length of time sufficient to utterly destroy most other batteries. The fatal objection to it, however, is the readiness with which the liquids in the cells are diffused through the diaphragm, requiring frequent recharge. The Leclanché—or the Law cell, which is a modification of the Leclanché, and in some respects to be preferred to it—is not constant in the sense that a Daniel's cell is, or a Grove or a Bunsen. If left short-circuited for any length of time through carelessness or accident, the owner may return to find his apparatus a wreck from which no current can be obtained. Used, however, through a high resistance, such as the human body, it retains its constancy for several hours, and even when finally weakened it regains its strength after a short interval of rest. With proper care it retains its vigor of action for many months, and in the case of the larger-sized cells for two years or more with very little attention. It is therefore for therapeutic purposes quite unapproached by most other forms of apparatus, and can confidently be recommended for the four qualities of constancy, strength, durability, and cleanliness.

Small Leclanché batteries for portable use have been constructed, but have failed to answer the purpose, for their very compactness has rendered them readily polarizable and easy to get out of order through secondary action. For portability combined with constancy the chloride-of-silver batteries can be highly commended. They are, however, costly, and another drawback is their extraordinarily high internal resistance, which necessitates a very much larger number of cells than other forms having only the same electro-motive force. As the Leclanché cell has an electro-motive force of one and a half volts, fifty of them would fully answer for every gynecological purpose.

By all means select large cells for office use. Holding a larger amount of material, they require charging less frequently and polarize with less readiness. Added to this, they are cheaper in proportion to the work they do, and are far less liable to get out of order.

Mention should also be made of the Edison electric-light current. It is a current of low tension, not exceeding 125 to 200 volts, and is therefore devoid of danger; furthermore, as the internal resistance is slight, it can be used for the purpose of galvano-cauterizing as well as electrolysis. Arrangements are now perfected by which this current can be conveyed direct from the dynamo into one's office and utilized for all practical work. It is readily appreciated that with a current of such a considerable voltage some resistance should at all times be kept in the circuit.

2. *The Milliampèremeter.*—The milliampèremeter is to the physician using electricity what the scales are to the apothecary dispensing his drugs; and while this instrument of precision is by no means always essential in every electro-therapeutical application, it is safe to say that electrical treatment in gynecological cases could never have advanced as it has done had it not been for this great improvement in the method of electrical measurement. Mathematical precision has been substituted for the uncertain and generally inaccurate estimates of current-strength in internal applications, and the operator is now able to compare day by day the varying potentials employed, and to put in definite language instructions as to further treatment to whomsoever he may wish permanently or temporarily to confide the case.[1]

3. *The Rheostat.*—There are two principal ways of gradually increasing and decreasing the strength of the current without interruption, the first and most common method being the ordinary current-selector attached to the element board of most stationary batteries. It is by no means the most certain or easy method, and in the majority of batteries as arranged it is impossible to manipulate these selectors without occasionally interrupting the current. It is therefore safer and more convenient to possess some form of water rheostat or some one of the various current-controllers in which the intercellular resistance is a solid instead of a fluid.

Of the water rheostats, the Bailey current-controller is perhaps as good as any. It is an improvement on the ordinary water tube-and-rod rheostat that has been in common use for so long a time in that it is possible to approximate more nearly the maximum meter-measurement that the whole number of cells employed is capable of giving. Instead of the rod, we have four broad carbon plates, which when immersed give a large surface contact, and which when lowered into or raised from the water increase or decrease the strength of the current through a very wide range of resistance.

4. *Internal Electrodes.*—The electrodes for internal use should be of two kinds—for extra- and intra-uterine applications. For extra-uterine applications within the vagina the electrodes consist of a ball or disk of brass or carbon mounted upon a long insulated stem. In using the faradic current these electrodes are not necessarily covered by any protecting material. Applications of this current through the mucous membrane of the uterus or vagina cause no more sensation with uncovered than with covered electrodes. With the galvanic current, however, it is very different, and the matter of covering is of considerable importance. Ordinary absorbent cotton answers very well, and is much to be preferred to sponge; but the best protection to the mucous tissues is a carefully adjusted covering of sculptor's clay held

[1] For further description of the milliampèremeter, see p. 139.

in place by any light material, such as the lightest form of unbleached towelling or tarlatan. The carbon electrode is to be used in connection with the positive pole, and through both electrodes, when protected in this way, much stronger currents can be borne without injuring the tissues than if used without such covering.

As regards the intra-uterine electrode, an ordinary Sims sound can often be used with much satisfaction, provided the introduction is made in the Sims position. In the dorsal position the shaft or stem in contact with the vaginal walls should of course be insulated; otherwise a part of the current will be conducted away before the intra-uterine portion is reached.

No matter, however, what the method of application, insulation is to be preferred, and in the various forms of intra-uterine electrodes found at the instrument-maker's the uninsulated portion varies from half an inch to two or more inches, suitable for applications to the different parts of the endometrium in detail. When the positive electrode is used internally, it should of course be of platinum or some other material that equally resists the oxidation that takes place at this pole. It has of late been found that by subjecting steel to certain processes it can be rendered unoxidizable, and as the cost is much less than platinum, it becomes a desirable substitution.

Other sounds, uninsulated except by a movable sheath made either of hard rubber or glass, are preferably used by some, and while they enable one to extend or decrease the area of the uninsulated and active part of the electrode at will, there are certain disadvantages connected with them. It is impossible, in the first place, to extend the insulating sheath beyond the curve of the instrument, and they are more likely to remain unclean.

5. *External Electrodes.*—With every appliance complete and of the best—battery, internal electrodes, and instruments of precision—one will yet fall far short of accomplishing the best results in the treatment of uterine disease without careful and correct attention to the character of the external or cutaneous electrode.

To Apostoli is due the credit of reducing to a system and practically applying the simple principle of physics familiar to all, that the larger the area the less the resistance. In all electro-therapeutical procedures the skin is the great obstacle to the efficiency of electrical action. With the ordinary sponge electrode, offering an immense resistance, it was not only impossible to obtain from any reasonable number of cells a current sufficiently strong to do effective work in many internal diseases, but the burning and pain under this external electrode readily became unbearable. The milliampèremeter, accurately registering the strength of the current, enabled us to appreciate the fact that it varied immensely according to the size and quality of the electrodes,

even although the number of cells in the circuit remained the same. To overcome in the least painful manner this great cutaneous resistance Apostoli, as is well known, suggested electrodes of sculptor's clay.

Sculptor's clay is readily obtained almost anywhere, and with a little attention to detail each one can prepare these electrodes for himself and with but little expense. In the selection of the clay be careful that it is free from all admixture of sand, and combining with the utmost plasticity as little stickiness as possible. The character in this respect of the various kinds of clay varies considerably, and a poor selection may cause unnecessary discouragement. The clay should be soft, but not very soft. Its conducting power depends, of course, upon the amount of water absorbed. If the mass is too hard, there will be manifestly less readiness of conduction; if too soft, it becomes nasty and difficult to keep in place. It should be just plastic enough to be readily moulded to the inequalities of surface, and to impregnate every pore without dropping apart or spreading beyond the limits intended. If successfully made, so that the finger can penetrate it without effort, it can be moulded and used without any covering whatever. As generally used, however, it is enveloped by the thinnest kind of towelling, or, better still, by coarse tarlatan, through the meshes of which it can easily transude, and which, when the clay would be too soft to use without a covering, keeps it in compact form. A suggestion of Dr. A. Lapthorn Smith is that a little glycerin, through its affinity for moisture, will when added to the clay greatly aid in keeping it soft and pliable. When not in use it is necessary, in order to preserve the humidity of this electrode, to keep it covered with oiled silk or rubber cloth. When ready for use the mass should be of uniform thickness, neither too thick nor too thin. If the former, it will offer an unnecessary resistance and weight; and if the latter, there is the risk, in the slight spreading that inevitably occurs, of the metallic disk which covers the back of the mass of clay, and through which the electricity is conducted to the clay, penetrating through the mass and coming in contact with the skin. These electrodes vary in size, according to the strength of current desired, from a few inches square to dimensions sufficient to cover nearly the entire abdomen.

6. *Operative Procedure.*—Intra-uterine galvano-cauterization, as well as the electrolysis of fibroids, requires currents of high tension. Bearing in mind this fact, the necessity of careful deliberation in carrying out the details of these operations becomes sufficiently evident. In applications, whether extra- or intra-uterine, the dorsal position is generally sufficient, and is indeed to be greatly preferred. Sometimes, however, the difficulty of introducing the intra-uterine electrode is so great, and perhaps insurmountable, that the Sims position is found necessary—a position that is by no means so favorable for an easy and

satisfactory adaptation of the cutaneous electrode as the dorsal. The abdomen is for many reasons the best position for this electrode, and, whether consisting of clay, of absorbent cotton, or other material, should be carefully adjusted and a few moments allowed for the skin to become thoroughly moistened before the introduction of the active electrode. Everything being in readiness, the current should be gradually increased, either by means of the current-selector or rheostat, until the milliampèremeter indicates the desired strength.

If the element-board is constructed properly, the current can be increased cell by cell with little if any danger of interruptions, and with the assurance that we are utilizing the total strength of the cells in the circuit. For absolute safety, however, the rheostat is to be preferred. The disadvantage of the water rheostats in common use is that, unlike the first method, we are unable to utilize the full strength of the cells in operation. This defect is in a measure overcome by the dry rheostat, several kinds of which are now obtainable.

Thorough antisepsis of both the hands and internal electrode is recommended. The current itself, however, is a good antiseptic, and experience shows that there is but little if any danger to be feared even if these thorough antiseptic measures are not adhered to. "The whole operative procedure," says Apostoli, "may be summed up in a good hysterometry, the operation itself being nothing more than a therapeutical passing of the sound where all traumatic action (except in the case of puncture) should disappear in order to give place to the highest degree of electro-chemical action. Manifestly, there can be no absolute standard as to the dose of electricity by any method or in any disease. Individuals vary immensely in their susceptibility, although the relative variation in the dose necessary to give, in the use of these intra-uterine electrodes or in the treatment of fibroids by puncture, is not so great as it is in external and purely non-surgical treatment. In the treatment of fibroids and in the galvano-chemical cauterization of the endometrium when we desire the destructive action of the current in the treatment of granulations and fungoid growths, a certain amount of work has to be done, and this requires a definite strength of current. In beginning these intra-uterine applications thirty or forty milliampères are often sufficient, to be carefully increased according to the susceptibility of the patient, until 100, or even in some cases 150, milliampères are reached. It is in the chronic catarrhal diseases of the endometrium, as well as in later pathological conditions, when the uterine parenchyma becomes involved, that these intra-uterine applications of high tension are particularly applicable; and much well-authenticated experience clearly shows that in many instances it possesses advantages over caustics, the knife, or the curette. A most important advantage over caustics or the galvano-cautery is that its

dose can be given with mathematical exactness, and according to the pole employed it is possible to obtain effects that are hæmostatic or congesting at will. Again, so gradually can we work up to the effect desired that the operation is devoid of those sudden and severe effects that are inevitably associated with other methods. While lesions of the uterine mucous membrane are amenable to the action of either pole according to the existing pathological condition—in the hæmorrhagic and profusely catarrhal forms the positive, and in others the negative pole—there finally, in many cases, comes a condition of the substance of the uterus which calls alone for the effects of the negative pole. These are the cases of chronic parenchymatous metritis which have baffled so often the best efforts of gynecologists by the old methods, but which bid fair to yield more readily to the new. In those cases of interstitial metritis which have reached the stage of induration some remedy that will act in a powerfully stimulating and derivative manner, that will excite the feeble and almost extinct circulation, hastening nutritive changes and quickening absorptive processes, is imperatively demanded." Such a remedy, says Apostoli, is found in "the negative pole, basic, diffluent, little or not at all hæmostatic, but, on the contrary, destined to excite the languid or perverted circulation and old, atrophic, or indurated forms of chronic metritis by a strong appeal to the intra-uterine circulation—the remedy, *par excellence*, for indurated chronic metritis, whether complicated with amenorrhœa or dysmenorrhœa; and it may be used with equal success in other inflammatory processes in which hæmorrhage does not predominate. The positive pole, acid, decongesting, hæmostatic in the highest degree, is especially useful in the hæmorrhagic, congestive, or ulcerative forms; it combats and prevents the tendency to excessive vascularization, and by the same process becomes an indirect treatment for rebellious leucorrhœa."

In the treatment of fibroid tumors even stronger currents are to be used than in the treatment of chronic metritis, and the same form of external electrode employed to enable the localization at the active pole of these strong currents. Intensities as high as 250 and 300 milliampères are frequently used, and on one occasion at my clinic at the New York Post-Graduate Medical School and Hospital, abandoning the external electrode and introducing two needles connected with either pole, directly through the abdominal walls into the tumor, I applied for five minutes a current of 400 milliampères without ill effect. Both electro-puncture and intra-uterine applications are successful in reducing the size of fibroids.

When the tumor is intramural, intra-uterine applications are undoubtedly to be preferred to electro-puncture, but there are many cases where the fibroid is so situated that applications to the cavity of the uterus would have comparatively little effect, and the indications are

for puncture. Deep puncture through the vaginal walls into the tumor is now considered by no means so necessary as formerly. The introduction of the uninsulated portion to the depth of a third of an inch only has, in my experience, answered every purpose, and is far less likely to be followed by bad results than deeper penetration.

For the absorption of pelvic exudations following cellulitis the galvanic current is invaluable. This treatment, persistently used, will dissipate pelvic deposits, and relieve severe sciatic pains due to the pressure of these exudations.

Stenosis of the cervical canal has been much relieved by galvanic treatment through the use of currents ranging from 40 to 75 milliampères. Using the negative pole, there seems to be little danger of any evil result, and the pain is quite slight.

Electricity in Obstetrics.

The use of electricity in midwifery is no new thing. As far back as the beginning of the present century it was recommended to hasten the expulsion of the fœtus, but it was not until a much later date that its use for this purpose excited any attention. "The indication for the use of electricity in midwifery is declared to be an adynamic condition of the uterus where other conditions are favorable for or necessitate immediate delivery."

There are many advocates of faradization in the last stages of delivery; and even in the first stage, when the labor has fairly begun, faradization of the lumbar region will sometimes hasten dilatation of the neck and excite the vigor of the uterine contractions. The current seems to have no ill effect on the fœtus, and indeed it is probable that but a small fraction of the current ever reaches the interior of the uterus.

There are very positive differences of opinion in regard to the value or necessity of faradization in hastening a confinement, but there should be no differences of opinion in regard to the use of the current in cases of post-partum hæmorrhage. The old method of introducing one electrode of an induction apparatus into the uterus and applying the other over the abdomen was in many cases efficient, and has undoubtedly saved many lives by the promptness with which it induced uterine contractions. The efficiency and promptness, however, of this method are not nearly so great as the bi-polar method, where both poles are introduced into the uterus and the induced current of quantity employed. In the treatment of post-partum hæmorrhage it is of the greatest importance that the wide difference between the action of the currents of quantity and tension on the uterine tissues be thoroughly appreciated. The current of tension when applied externally produces most vigorous muscular contractions, but when applied internally its effects are modi-

fied in a most remarkable degree. If the uni-polar method is used, the external electrode will still produce strong contractions, while the internal electrode is hardly felt. Using the same current with both poles applied internally, the contractions that are produced are comparatively slight and inefficient, and in a dilated and inert condition of the uterus it is entirely probable that it would exert not the slightest effect. The current of quantity, however, which when applied externally possesses but little appreciable effect, acts with extraordinary vigor when applied internally to the uterus or vagina. One who is accustomed only to external applications, or who has given no attention to this most interesting electro-physiological and therapeutical phenomenon, would very naturally, if suddenly called upon to treat a case of post-partum hæmorrhage, use the current of tension, which ordinary experience has shown to be so much stronger than the other. In doing this, however, he would be likely, if there existed a marked adynamic condition of the uterus, to utterly fail in inducing any adequate muscular contractions, and fatal hæmorrhage ensue with a remedy at hand capable of successfully combating it.

Electricity has occasionally been successfully used to increase a deficient lacteal secretion. Both the galvanic and faradic currents have been used with apparent effect, but the faradic current, on account of its greater mechanical effect, is perhaps to be preferred. In using electricity, however, for this purpose it should be borne in mind that overstimulation may do positive harm in dissipating the slight secretion of milk that may still be present.

The latest and one of the most important uses of electricity is in extra-uterine pregnancy. If this condition was a common one, it is safe to say that no therapeutic procedure of our time would exceed it in importance and general interest.

While there exists much diversity of opinion as to the value of the method in this condition, some even going so far as to condemn it *in toto*, the very important and suggestive fact should not be forgotten that those who thus condemn it are, as a rule, of the number who have had no adequate personal experience in the matter. From the standpoint of the writer, who has personally treated by electricity as many if not more cases of ectopic gestation than any other, the method clearly seems to be the best, and the only one that should be attempted in the earlier stages.

As early as 1872 electricity was successfully used in these cases for the destruction of the fœtal life, but it was not until 1878 that the details of the method excited any general interest in the profession or incited others to make similar attempts. In that year a case occurred in the practice of Dr. Charles McBurney of New York, and in a consultation with Drs. T. Gaillard Thomas and T. Addis Emmet, Dr.

Thomas suggested the possibility of the use of electricity instead of the knife. When questioned as to the possibility of the operation, I replied that the destruction of the fœtal life was an easy matter, and that it could probably be readily accomplished without special pain or injury to the mother. The results of the attempt, immediately made, fully justified this prediction, and there soon followed many reports of similar cases equally satisfactory. The operation is simplicity itself: One electrode is applied internally, pressed as closely as possible against the fœtal mass, while the other is applied on the abdomen immediately over it. Both currents have been successfully used. If the faradic current is attempted, either pole may be used internally, although the negative is to be preferred. The negative pole is also to be preferred in the use of the galvanic current for this purpose, and is the current which in my opinion performs the work required of it with the greatest certainty and efficiency. An interrupted rather than a continuous current is to be employed, although there may be an advantage in its rapid increase by means of a rheostat. In this way the chemical and physiological effects can be greatly increased, without the disagreeable effects, and even the danger, that might accompany an interruption of the same strength of current. In cases that are somewhat far advanced the danger to be apprehended from an injudicious application of the faradic or the interrupted galvanic current is the possibility of rupturing the over-distended tube. In one case, where the pregnancy had advanced nearly to the fourth month, the necessity for caution forcibly presented itself to me. By gradually increasing and as gradually decreasing the strength of the current I was enabled without fear to make use of a much stronger current than if interruptions had been made, and in this way succeeded in destroying the fœtal life. In regard to the position of the poles, my custom has been to place the positive pole externally. This should consist of a broad, flat sponge pressed firmly on the skin and directly over that portion of the tube where the fœtus is developing. The negative pole is used internally, and may be carried up to the fœtal mass through either the vagina or rectum, according to the position and size of the tumor. In fifteen cases that I have recorded the operation was performed through the vagina in twelve and the rectum in three.

As there seems to be no way of determining positively whether the fœtal life is immediately destroyed by the first application, it has been my custom to repeat it three or four times; and as but little pain is caused, there can be no objection to its repetition on this score. All medical and surgical procedures, however, that are not absolutely necessary are objectionable, and a remote possibility even of an accident of the kind to which reference has been made—viz. rupture of the tube—suggests that these applications be made no more frequently than will

suffice to accomplish our object. It is proper to say, therefore, that a strength of current just sufficient to destroy the fœtal life is, in all probability, capable of doing it at once, and that all subsequent efforts serve only the purpose of hastening the process of absorption. Applications that are made for this purpose alone cannot be at all objectionable, as the uninterrupted galvanic current is the form indicated. Even to this day there are many who suppose that the operation is purely electrolytic, necessitating the introduction of a needle into the fœtal nest. Happily, such is not the case, for any such procedure might itself be attended with danger, and certainly with considerable pain. The negative electrode consists of a metal ball, and is applied *to* and not *into* the tumor.

Electrolysis.

Electrolysis is more especially a surgical procedure, and, strictly speaking, perhaps has no place in a work of this character. Every passage of a galvanic current, however, through any compound substance is undoubtedly accompanied by some chemical or electrolytic change, although manifestly very slight in degree.

When the electrodes of a galvanic battery are immersed in water and the circuit closed, a more or less abundant evolution of gas takes place. Oxygen appears at the positive pole or anode, and hydrogen at the negative pole or cathode, and the water is separated into its constituent elements. This is termed "electrolysis," the act of decomposing a compound substance by electricity. If a salt solution is subjected to the action of the current, the process is similar, but more complex, the acid being set free at the positive and the alkali at the negative pole. The accepted theory of electrolysis is in harmony with the statement just made, that the passage of a current through the body is associated in every part of its course with more or less chemical action. In every compound one of the elements is electro-positive and the other electro-negative. Under the influence of the opposing electricities from the electrodes decompositions and recompositions go on from one pole to the other. But these decompositions and recompositions are seen only at the electrodes. Water is composed of one atom of oxygen and two atoms of hydrogen. Oxygen is electro-negative, and hydrogen is electro-positive. When, now, the electrodes are dipped in water, the electro-negative oxygen of a molecule of water is attracted to the positive pole, and the electro-positive hydrogen is repelled. The oxygen is then given off at the positive pole, while the liberated hydrogen unites itself with the next atom of oxygen, and the original atom of hydrogen is expelled. This atom of hydrogen unites with the oxygen of the next molecule, drives out the hydrogen with which that alone has been previously combined, and so on through the whole series of molecules until the negative pole is reached. Here the

hydrogen has no more oxygen to combine with it and is liberated as gas. Thus, while the decomposed elements appear only at the electrodes, the intermediate regions presenting no change, it is necessarily traversed by the decompositions that occur.

There is no evidence that organization as such seriously modifies electro-chemical decomposition. The fluids of the body decompose under the influence of the current, just as the same combination of fluids with tissue would decompose if not endowed with life. The great difference, however, in the effects of electrolysis on organic and inorganic substances is seen after the current has ceased to act. In the electrolysis of most inorganic substances—such, for example, as iodide of potassium, acetate of lead, chloride of sodium, etc.—the effects cease as soon as the current ceases; the substances remain in the condition that the current left them. The electrolysis of organic substances starts a process that continues long after the current ceases to flow.

It is to this secondary effect of the current that we must ascribe the gradual but complete disappearance of some small tumors following one or more electrolytic operations. A young woman aged twenty-two came to me some years ago with a goitre of considerable size that had been developing since the age of sixteen years. Electrolysis was used only four times in this case, and at intervals of a week. An appreciable reduction of size was evident, after which the patient came no more. The tumor, however, continued to decrease, and when I saw her, a year subsequently, had entirely disappeared. Such results are rare, but it is not very unusual to witness some further reduction of goitres, and even fibroids, after the cessation of treatment.

Nothing can be more satisfactory than the readiness with which erectile tumors are cured by the introduction of one or more insulated needles and a judicious management of the chemical or electrolytic action of the current.

Reference is not made here to the widespread dilatation of cutaneous vessels, attended with little swelling, commonly called mother's mark, but rather to the subcutaneous variety called aneurism by anastomosis, which may be either venous or arterial. The great advantage possessed by electrolysis is that it cures, provided that the conditions of success be skilfully observed, without hæmorrhage and with little or no scar. When the tumors are situated on parts hidden by the clothing this is not always considered of such great consequence, but when situated on the face, as is so often the case, it is of vital importance. The needles must have a perfect insulation up to within a distance from the point varying from a few lines to a quarter of an inch, so that the skin may be thoroughly protected.

We must do just enough, without doing too much. If the current is too strong or the application too prolonged, the destruction may be

greater than is required, followed by a discharge of pus; and this may result in cicatrization. If the current is too weak and the treatment too short, the tumor may re-establish itself, necessitating a repetition of the operation. It is not claimed that all nævi can be cured without a scar, but many can be; and in the large ones, where the chemical effects of the current extend to the skin, the patient, if a child, rapidly outgrows them. Both poles may be used, connected with the needles, but my experience in a large number of cases is in favor of only one pole in the tumor, the other being applied externally on some indifferent point by means of a sponge electrode. The needle should by preference be connected with the positive pole, since the coagulation at this pole is more rapid and firmer than at the other. If the tumor is small one needle may be sufficient, but if large, needles may be connected with both poles.

THE REST-CURE FOR NEURASTHENIA AND HYSTERIA.

BY JOHN K. MITCHELL, M. D.

THE system of treatment for the varying conditions of neurasthenia, hysteria, and certain nervous troubles by REST, including in this term all those developments in the direction of passive exercise, full feeding, and isolation, which I shall have to consider in this article, was first *publicly described by Dr. S. Weir Mitchell in a lecture published in 1875 in vol. i. of Seguin's series of *American Clinical Lectures.* In 1877, Dr. Mitchell published a more elaborate description of it in an essay entitled *Fat and Blood*, of which the fifth edition was issued in 1888. Dr. William Playfair of London has used the method and written upon it in England.[1] The present article may be considered as an authoritative statement of the most recent views of Dr. S. Weir Mitchell, and of the latest developments in this method of treatment.

A few words, first, upon the state which we describe by the vague names of "neurasthenia" and "hysteria."

The terms "neurasthenia" and "nervous prostration" are drag-nets that gather up a motley multitude of ill-defined cases which it would be difficult briefly to define. Neurasthenia is a condition made up of subjective symptoms, yet no one symptom is constantly present in all cases. Nervous exhaustion is a phrase used as equivalent to neurasthenia, but excitation of the nervous system is frequently added to the weakness. Usually we find the nervous system both feeble and irritable, and wherever the manifestations appear, whether they be in the circulation, in the gastro-intestinal tract, or in the cerebro-spinal centres, these characteristics of feebleness and irritability are shown.

Certain cardinal symptoms are tolerably constant, however varied the lesser signs may be, which Charcot calls the "neurasthenic stigmata." These are insomnia, headache, enfeeblement of motor-power, dyspepsia, backache (especially in women), and usually brain-fag in some degree. Some of these symptoms are among the earliest signs which the patient observes. To illustrate them very briefly: the *insomnia* is of many kinds and degrees, from mere restlessness and broken sleep to almost total loss of the power to sleep, lasting for weeks

[1] *The Systematic Treatment of Nerve-Prostration and Hysteria*, London, 1883.

or months. This is one of the symptoms which result in endless evil, owing to the hypnotics and narcotics given in the attempt to overcome it.

The *headache* is often rather a distress than a pain, and is very constantly present in neurasthenic patients. Its common seats are the frontal, occipital, or nuchal regions, but it may be anywhere in the head, and varies from a heaviness or fulness to an agony. It is made worse by mental effort, sometimes by movement, and it may be accompanied with vertigo or with subjective aural or visual disturbances.

Of all the symptoms which neurasthenia presents, the most constant is *loss of motor-power*, an utter incapability of sustained muscular effort. It is absent only in the rare cases which may be described as simple brain-fag. Even the smallest effort is a severe exertion, and results in fatigue out of all proportion to the power put forth, or is followed by vomiting or nausea or diarrhœa. Examination will reveal no paralysis, and the reflexes will be unaltered or slightly exaggerated.

The *cerebral fatigue* or depression is of the same kind as the muscular prostration. To attempt to fix the attention, even to observe an action or a picture carefully, to talk even of trivial things, results in unusual fatigue of mind and makes the headache worse. The will, the judgment, the moral control, are weakened or in some bad cases perverted, so that a man of a pleasant temperament becomes aggressive, contradictory, and irritable.

Gastro-intestinal indigestion is often thought to be the cause of the neurasthenia. It is certainly very constantly an accompaniment of it, but in many cases it is rather a result of the general depression than a cause. When it exists the most common complaint is loss of appetite, together with an epigastric weight and fulness after eating, followed by eructations of gas, and there is generally troublesome constipation.

Backache, especially in the region of the sacrum, is frequent, and in women the subjects of neurasthenia it is almost invariably present.

Besides these cardinal points, innumerable lesser symptoms add to or complicate the diagnosis, and neurasthenia is associated with, and runs into, hysterical conditions, so that no one can draw an absolute line between them. A tender spine, anæmia, ovarian neuralgia, wandering pains about the body, a rapid and irritable heart, troubles of sight and hearing,—all may play their parts in adding to the difficulties of treatment. When to these emotional manifestations or to some of them are added contractures, paraplegias, or disturbances of sensibility, we call the patient hysterical, even though she has no disease of the womb or ovaries.

Having very briefly mentioned the symptoms, we have to consider the varieties of neurasthenic troubles which are proper for submission

to treatment by rest. Not all cases of neurasthenia or hysteria are suitable for it. While we have other means at our disposal, it would be most unwise to order, without discrimination, all "nervous" patients into bed—to force upon them a life which involves separation from their friends, the entire attention of one or more attendants, and consequent great expense. It is only when other ways have failed to cure that we should use the rest-treatment. Further than this, many persons are individually unsuited for it. If the nervous prostration be complicated with melancholia, the rest-cure almost never does good. The habit of too minute analysis of their own symptoms, of microscopic investigation of their moral and mental condition, to which sufferers from melancholia are prone, is only fostered by the opportunities offered by confinement in bed and consequent inaction. If to melancholia a suicidal mania be added, it is especially undesirable. The depression increases, the loss of appetite usually becomes greater, and the case grows worse, not better. For such cases active exercise is preferable to the passive movements of massage, and open air and movement are better tonics than those of the apothecary.

Acute uterine or peri-uterine disease, while it lasts, contraindicates the rest-treatment. The forms of chronic ovarian disease, for which Battey's operation is usually the only recourse, improve, but seldom recover, though they may improve sufficiently to make surgical interference both easier and more successful. Without such interference they are rarely cured. Advanced Bright's disease or advanced phthisis forbids the use of such a course, but the earlier stages of these diseases may be successfully treated in this way. The cases which do best are bed-ridden hysterical patients suffering from that extraordinary variety of symptoms which make the hysterical panorama—wasted, without appetite, with localized anæsthesias or contractures, morbidly dependent upon sympathy, at once the despair and the livelihood of many physicians. The worse these cases are, the more emaciated, the more hysterical, the more hopeless in appearance, the easier is the cure as a general rule.

The most important indication in favor of this course is found in the patients who have, together with the severer forms of neurasthenia or hysteria, that moral degeneration which is present with them so frequently, and those to whom a too anxious family offer overwhelming attention and sympathy.

In treatment a distinction must be made between the two varieties of neurasthenia to which the French have given the names of "myelasthenia" and "cerebrasthenia." In the latter a man who is prostrated by too much intellectual work or strain, and yet is not physically exhausted, should be treated by having his activity, mental and bodily, measured for him in definite doses. In the former, in which the spinal

or medullary centres are in trouble, isolation and rest must be practised. Great anæmia and its congeners, chlorosis and leukæmia, are well treated in this way.

It is hardly necessary to say that a large proportion of neurasthenic patients are women. Indeed, as a rule, rest-treatment is not a means which acts well with men, although there are exceptions. The reasons for this fact are not far to seek. Men are more accustomed to activity. They are less amenable to the necessary discipline, they are more impatient of small restrictions and of slow progress. They seldom get so far advanced in hysterical disease as women, and simulated disease is rare among them. Change is easier to women. They are more accustomed to go up and down physically. A woman loses weight every month with her menstrual flow, and to gain and lose flesh is physiological with the female sex, as it is not with the male. Every physician who has had much hospital experience has noted how much less women are affected by loss of blood than men. Even in hæmorrhages from wounds this is true, and how constantly we see menorrhagia followed by extraordinarily rapid recovery! In a few days the patient will have returned to a nearly normal state, whereas were a man to lose a like amount of blood we should have to help him through a long course of iron and tonics before he could recover; and these tendencies repeat themselves both as to disease and as to therapeutics. Dr. Kleen, in the excellent book on massage which he has recently published,[1] does not find this difficulty, but his patients appear to have been mostly of German origin, and perhaps racial differences may account for the ease with which he succeeded in keeping men in bed for six weeks.

Other important indications for this treatment are found in those conspicuous defects of nutrition which evidently unfit an individual for the use of the muscles. In a person in whom a trifling over-exertion results in a great emotional display no improvement will take place until the nutrition is improved. Harm will be done by making such a person drag himself about, and a more complete breakdown will be the result. Fortunately, rest is a medicine from which little harm can come, so that when we are in doubt we may be sure that we are at least on the safe side by prescribing it.

One danger, it is said, of putting a patient to rest in bed is that we may not be able to make her get out of bed again when the proper time has come; but this does not seem a very serious danger; at least, it is one which the writer has never experienced.

The most important element of all is one which is of weight in any treatment of every disease—the personal element. One physician succeeds where another, equally as able, fails. Important as the question

[1] *Handbuch der Massage*, Dr. Emil Kleen, Berlin, 1890.

of the physician's share in the case may be, it is hardly possible to discuss it here, but it is well to remember that faith is a good adjuvant to even the most active drugs, and faith in the doctor the patient must have, especially in a treatment in which the progress is often so slow and the gain from time to time so little apparent.

The usual beginning of the cases needing rest-treatment is in some exhausting physical or mental strain. Sometimes an illness from which the patient has never entirely convalesced is the starting-point, or a local uterine or ovarian trouble. The patient presently grows pallid, wastes, loses appetite, or, if she eats, her food seems to do her no good. The smallest exertion is followed by disproportionate fatigue. The effort of keeping up social relations leaves her daily more and more exhausted. She begins to sleep badly, has indigestion, is constipated, and is incessantly becoming feebler. If she is of an emotional nature, this tendency becomes more and more dominant until her emotions rule her. Even if she were previously not emotional, she presently becomes so. "The moral degradation which such cases undergo is pitiable. The result is to cultivate self-love and selfishness, and to take away by slow degrees the healthful mastery which all human beings should retain over their own emotions and wants." A physical examination of such a case will perhaps disclose no organic changes. A trifling exertion excites the heart unduly. If there is great anæmia, a hæmic murmur may be heard over the heart at the base. A tender spine, tender ovaries, and asthenopia are often found, but further than this we can observe little wrong. An examination of the blood reveals the ordinary features of the different grades of anæmia—diminished hæmoglobin and a lessened number of corpuscles—but for the host of aches and pains of which the patient will speak no adequate physical causes can be found.

What shall we do with such a case? The sufferer has run the gauntlet of tonics, has been stimulated with alcohol, has been depressed, and had her digestion upset with bromides and perhaps with opium; she has tried without success to secure sleep by chloral or other hypnotics; she has been through water-cures and sanitariums; she has tried Christian science and skepticism.

An endeavor will be made in these pages to describe the method of handling such cases, so that a physician with no previous experience of it may discover how to apply this treatment to the bettering of this melancholy array of symptoms. The means to be used consist of isolation, rest in bed, passive exercise, certain forms of diet, and electricity. How far these means should be modified in different cases will be pointed out under each head. It may be said that during cold weather is the best time for applying this treatment, but hot weather,

unless there is excessive heat, need not forbid it. Women should begin treatment immediately after a menstrual period.

Isolation.—The first point to be considered in detail is that of seclusion. No other single feature is of such importance; to no other is it so difficult to secure consent. Even when the patient is willing, the family sometimes are not. It is easier to seclude a patient away from home, but if any success is to attend upon the application of this treatment, somehow the patient must be separated from friends and relatives. Naturally, in a patient's own house this is not easy. It seems hard to a mother or sister that she must be kept upon the far side of the door from the invalid, and not allowed to see her for five minutes; but in neurasthenic and hysterical patients the sympathy which they extract from those who surround them is a food which nourishes their disease. Then, too, this isolation is useful from the total change of moral atmosphere, and from the fact that as the patient grows better she is more and more anxious to escape from the enforced seclusion, and adds her own efforts to those of the physician and attendants.

Cases of myelasthenia, of purely physical prostration from overwork, from hæmorrhage, or from nervous breakdown where there is no hysterical element, may be handled in their own homes, and need not be so entirely separated from their friends. But the neurasthenic, the hysterical, the morbidly fanciful patient, or the one with simulated disease should be rigorously separated from all her acquaintances, away from her family, receiving no letters and sending none. There is another reason why this seclusion is useful. By it one is enabled to gauge the amount of the emotional element in the case—to see how far it is due to the patient's own disposition, and how far it arises from or is increased by her surroundings. If the disease is simulated, she will soon find the audience too limited for the successful production of dramatic effect.

As to the place in which to treat the patient, the best one of all is either a well-managed boarding-house devoted to such uses or a good private hospital. Such cases do not do well in a hospital ward, and even in private rooms in a general hospital it is for many reasons rare to meet with success. If a patient is placed in a private room of a general hospital, it is well to direct that the resident physician shall make but one visit daily, in order that she may not have this addition to her audience.

For any person absolutely at rest in bed a nurse is needed. In a hospital one attendant can care for five or six persons, as she is always within call, but in a private house it is best to have a nurse devoted entirely to each patient. Besides this attendant the patient will see only the doctor and the person who does the rubbing which is necessary.

Too much consideration cannot be given to the selection of a nurse. Now and then these cases can be carried through with the aid of an unusually firm and intelligent relative as a care-taker, but the nurse should be a stranger to her patient if this is possible; and should the patient come into the physician's hands with a nurse accompanying her, it is usually best to discharge this nurse.

One of the first qualifications of a good nurse is youth. Even experienced and scrupulously painstaking attendants lose, as they grow older in their business, that enthusiasm which is the prerogative of youth, and unless they are unusually conscientious this lack is not well replaced by increased experience. But youth, of course, is a relative term, and there are occasional nurses who seem never to grow old in this way. Quite beyond the qualities useful in a nurse for ordinary acute cases, a woman who is to have to do with hysterical patients must have keen observation, tact, discretion, intelligence, and a certain delicacy of feeling and of manner, or else the sensitive nerves of the patient will certainly revolt. She must be observing, for much of the physician's knowledge of the case and its peculiarities will depend upon her report. She must have discretion enough to know when to tighten and when to relax the reins of discipline—when to yield without giving up, and when absolutely to refuse to bend to the numberless fancies of her patient. Over-harshness will perhaps produce worse effects than too easy yielding. The nurse must remember that in enforcing discipline she should never come to an open fight with the patient; if she does, it has to be reported to the physician, and the nurse is put in the position of a spy and an enemy by it. Let her drop upon the doctor's shoulders the responsibility of an annoying decision. It is better that the patient should think that the doctor is the author of the disagreeable necessary discipline and the strict enforcer of the letter of the law, than the nurse, whom she should learn to regard as her best friend.

The nurse should make it a rule to follow the physician out of the room for a discussion of orders, symptoms, and questions of management. Neither these nor therapeutic matters should ever be talked over before the patient. If this going out is a matter of daily routine, the patient will not be suspicious of it, whereas if it be done but once in a great while she will be sure to fancy that it means complaint or tale-bearing or the gossip of the sick-room. On the other hand, it is well to talk with the patient freely about the nurse, and to consider her opinion, for, after all, she is the person most interested, and to have a daily talk with her without the restraining presence of the nurse. If the case does not do well, and it is not possible to find a clear reason for it, if the food seems to be well assimilated, the functions to be properly performed, and yet the patient does not advance, the attendant should be

changed. There should be no hesitation in removing the nurse if she and the patient do not seem to get along well together. Even the best nurses will not agree with every patient, and the writer has recently had occasion to provide three nurses in as many weeks for one lady, although at the same time he was not able to find fault with any of the nurses. Still, we are too apt always to fancy that these difficulties are the patient's fault; often enough they are really the nurse's, for it is a necessary part of the nurse's business to be able to get along well with nagging or fretting patients.

Some other minor qualities must be looked for also in the nurse with whom a patient is to be in close confinement for two or three months. She should be able to read aloud well, and to write a good letter, and she must have intelligence enough to perceive how to interest her patient in little things as she grows better, and to keep her sufficiently occupied to lessen the monotony of the sick-room.

As to the difficulties which follow isolation, they are fewer than at first seem likely. Occasionally patients when first separated from their usual surroundings have an access of emotional symptoms or crises which may last for several days. Only time is needed to relieve this. As to the duration of the isolation, it is hard to make a rule. In milder cases six or eight weeks of it will be enough to produce the effect desired, and the patient may afterward gradually return to her ordinary avocations in society; but the more grave hysterical cases it is sometimes necessary to keep isolated for many months, and inveterate hysterical performers will relapse when seemingly well if the cure is not well established and, as it were, clinched by a careful and methodical life without excitement for months after the cessation of active treatment. The medical attendant must be the judge of how long this seclusion should last. Toward the end letters are allowed to be received limited in number, and later permission is given to write briefly once or twice weekly to her family. Isolation is not a matter of weeks and months, but of results. The results which we desire to obtain are to separate the patient from the habits of long illness, from the too tender solicitude of her family or friends, to restore the enfeebled will-power and strengthen the morale, and make the invalid once more able to bear her part in every-day life.

Rest.—The second point of the method is rest. This too, like the isolation, is often badly borne during the first few days, but it is astonishing after a time to see how an active and stirring woman will settle down to a life of absolute immobility, and find it not only not disagreeable, but much to her taste.

Rest in these cases is a relative term, and varies from merely lying down for a few hours during the day to entire inaction in bed, carried even to the extent of forbidding the patient to feed herself or to turn

herself over. Such strict measures are only necessary in those grave cases in which there is great exhaustion alike of the cerebral and spinal centres. In them no more than the necessary interchange of speech should be permitted. At first, in very serious cases, food is taken better and in larger quantities if the nurse feed the patient than if the patient use her own hands to serve herself. It is, however, seldom necessary to carry the prescription of rest to so extreme a point as this. Ordinarily, the patient is allowed to feed herself while lying upon her back, being only allowed to sit up for the carrying out of her natural functions. In this way no demands are made upon the over-strained nervous centres. The voluntary muscles are not used, the mind is kept as inactive as possible, and the circulation is lowered, to the great easing of the nervous palpitation from which so many cases suffer.

The disadvantages of rest are that it lessens the appetite, that it increases the constipation, which nearly always exists in hysterical and neurasthenic people, and lowers the power of assimilation. These inconveniences we endeavor to remedy by passive exercise, as will be described later on.

When decided improvement begins to be visible in a patient's general state the rest becomes less absolute. A beginning is made by allowing the patient to sit up in bed at meal-time ; then for ten minutes twice a day in a chair while her bed is being put in order. This is usually not permitted before the middle of the second month : probably four weeks is the *least* period of rest which is likely to produce favorable results. This sitting up is gradually increased by periods of five or ten minutes daily until the patient is sitting up about an hour twice a day. She then begins to take a few steps, and in favorable cases the exercise is rapidly increased, until at the end of perhaps ten days from her first efforts at walking she is sent for a drive, walking being at the same time kept up and daily increased until a reasonable amount of active exercise is taken. The patient is not permitted to make the unnecessary exertion of going up and down stairs at first, but is carried in a chair to and from her room and her carriage. Often at this point a difficulty is encountered in those confirmed hysterics who prefer a life of easy invalidism to the burdens which physical well-being and activity impose upon them. They complain that in spite of increased flesh and apparent increase of muscular ability exertion causes pain in the spine, headache, indigestion, and fatigue. But if it is certain that they are well nourished, they should be remorselessly driven by the nurse and the doctor to taking the prescribed daily exercise, and told that the more they disregard the symptoms which result from exertion the less trouble they will give. If they have that necessary faith of which we have previously

spoken, they will soon learn the truth of this. Perhaps this is cure by suggestion, but if it be a cure, what matters the name?

For many months, even after an apparent return to perfect health, it is well to direct a certain amount of daily repose, for an hour after each meal, with no occupation, neither talking nor reading, during this time.

Diet.—Next comes the question of food. The patient before beginning her rest should be weighed, that there may be some absolute criterion of the gain made. Dr. S. Weir Mitchell does not, so constantly as he formerly did, begin with an absolute milk diet, finding that many patients do well on a modified diet *plus* milk. But when digestion is impaired or there is gastro-intestinal atony like the asthenia which affects the nerves and muscles, when entire loss of appetite is present, or that hysterical anorexia to which all foods are loathsome, and the patient is in a fair way to become a starving phenomenon, milk diet is the best starting-point. Every day one sees patients struck with horror at the idea of being fed on milk alone or milk at all. They say that milk from their earliest days has disagreed with them; that it upsets the stomach; that it constipates the bowels; that it causes endless strange difficulties. In spite of these assertions, it is rare to find a person who cannot really take milk when it is insisted upon. Sometimes it is necessary to begin with what seem absurdly small amounts—a tablespoonful of skimmed milk four or five times a day, increasing the dose, and gradually increasing the amount of milk while decreasing the other food. Four or five days of milk to start with, even in those cases in which no long continuance of this diet is intended, clears the way for other dietetic or therapeutic measures. In any case only skimmed milk should be used, and it should be fresh and in good order. If no difficulty in taking milk is experienced a quantity of about four ounces may be given every two hours, warm or cold as suits the patient, increasing to eight or ten ounces every two hours. In those to whom the taste after a time grows unpleasant caramel may be added, or chocolate, or a spoonful of coffee or tea, as a flavoring. Some persons do better with barley-water or rice-water added to the milk, and some with lime-water, but in much the largest proportion of persons carefully skimmed milk without any addition is sufficient. In the occasional cases which cannot take milk in any other form it may be given *partially* peptonized with Fairchild's extract of pancreas; and if this is carried to a very limited degree or the peptonizing agent is only added to the milk as it is handed to the patient, the disagreeable bitterness which results from completely peptonizing is avoided; or koumyss may be given, or Nestlé's Food substituted for a portion of the milk, or used alone if the prejudice against milk is inexorable. Milk frothed with Vichy or ordinary carbonated water is sometimes liked and easily taken. A cup

of black coffee in the morning when awaking is sometimes well borne, and frequently without further medicine will keep the bowels in order.

Dr. Kleen contends that milk, though it serves well for children, is not a complete or ideal food for adults, but this is a contention it is difficult to support. It is a complete food if given in sufficient quantity. One case has come under the writer's observation in which a gentleman with advanced diabetes and beginning nephritis lived in comparative comfort, carried on large business interests, and led an active existence for seven years on milk alone. The ease with which it is measured as a food is a great advantage. It lessens irritation in all organs; it makes the patient sleepy; even alone it seems a competent means of fighting hysteria. In nephritis and in diabetes nothing has been found to equal this diet; in stone in the bladder the frequent urination is relieved by a milk diet, and so marked is the result that Paget has suggested that before lithotomy the patient should be fed for some days on milk alone.

If the milk is used at first, after four or five days the patient receives a single chop at mid-day; the next day a piece of toast or bread-and-butter at supper. These two meals are increased slowly for a day or two, then breakfast is added, and when by small advances the patient has arrived at taking three full meals and two quarts or thereabouts of milk a day, it may be advisable to substitute for a portion of the milk some other food, such as Nestlé's or one of the several peptone preparations,[1] or some of the peptonized foods, the recipes for which are to be found in the books published by the makers of the peptonizing powders.[2]

Massage.—Massage is a matter about which much mystery is made and a good deal of nonsense talked. Some people regard it as a mysterious or miraculous process, like the "laying-on of hands" of the "natural healer," which produces great results in some strange way that we cannot comprehend.

Many different systems are in use, but the really essential parts of the ordinary practice of general massage may be written down in a couple of pages, though of course it cannot be *taught* in that space, for much practice, with careful watching of the progress of the pupil, is necessary to a reasonable perfection in the art. But, given to begin with a certain natural aptitude in the use of the hands, any ordinarily intelligent person who is strong enough can learn it.

[1] Most of the "peptones," "peptonoids," "beef-peptones," and so on, as commercially offered, are either of an extremely disagreeable odor or a very sweet taste which is obnoxious to sensitive palates. This latter trouble arises from their preservation by glycerin, which is often in such excess as to act as a purgative. There are, however, two or three excellent preparations, and especial mention may be made of the French "wines of peptone," which have given very good results as tonics and nutriments in the writer's hands.

[2] For dietetic tables see Dr. Yeo's article, p. 691.

For the less severe cases sometimes the nurse may be the rubber, but in the more seriously ill the nurse is so much occupied with other things that to ask her to rub the patient becomes a somewhat severe tax physically. If the physician have no previous knowledge of the qualifications of the masseuse, it is well to see the first treatment or two, lest it should be wrongly done. The ordinary professional rubber has a number of fixed ideas of her own from which it is difficult to wean her, nor does she usually care to learn afresh, in order to meet the views of the physician, a business in which she considers herself quite perfect.[1]

Systematic massage should begin within the first forty-eight hours after the patient is put to bed, and be continued daily for a length of time which will vary with the progress and requirements of the case. It should begin with gentle stroking of the whole body for from fifteen to twenty minutes, for two or three days, then going on to thorough deep massage of the entire surface of the body and limbs, exclusive of the head and neck, and be rapidly increased in duration to an hour or an hour and a half daily. It is rare to find patients who do not, after the first few treatments, bear it well. Now and then one is seen in whom rubbing is followed by a chill or by exhaustion so extreme as to forbid its repetition. Dr. Playfair has found it useful in many cases to order its administration twice daily; and this may sometimes serve, but care must be taken not to over-exercise the muscles of the patient in this way. Dr. Playfair gives one excellent practical hint. He says that he does not care to see that the massage is being effectually carried out. If after a week's rubbing the patient is not taking easily the amount of food prescribed and perfectly assimilating it, the massage is undoubtedly being badly done. The muscle-waste is not being produced which will admit of so much food being absorbed. The proper test is the patient's power of consuming and digesting food.

Another point may be mentioned: that if weighing shows the patient's weight to be increasing with abnormal rapidity, either the massage is not sufficiently thorough or the diet needs regulating in a different way.

Attention should be paid here and throughout the whole course of the case to the urine, as the appearance in it of a deposit of urates is an indication that assimilation is not perfect, and that the patient is taking an amount of food which it is not possible for the system to utilize.

One of the most important parts of the application is the thorough

[1] For extended information upon the movements and technical processes of massage the reader is referred to the article on "Massage" in this volume by Dr. Benjamin Lee or to Dr. Kleen's book, already mentioned (*Handbuch der Massage*), which is far the best upon the subject that has come under the writer's notice.

rubbing of the abdomen. This is especially desirable in view of the frequency of obstinate constipation, both in hysterical cases and in persons long in bed. For this the patient should lie upon the back with the head and shoulders somewhat raised and with the thighs slightly bent, and be told to breathe freely and not to make tense the muscles of the abdomen. This last is an order which will be found difficult to obey at first, but which soon is readily followed. The rubber, using either the heel of the hand or the three middle fingers together, begins with a firm, deep pressure, one hand following the other with a slight circular movement, and with sufficient pressure upon the skin to prevent its slipping from under the fingers. This motion is begun in the right iliac region, working gradually upward into the gastric and hypochondriac regions, across at the margin of the ribs, and downward again to the symphysis pubis. In this way every square inch of the ascending, transverse, and descending colon is gone over, except those parts which it is anatomically impossible to reach, the right and left flexures.

For action especially upon the stomach the gastric and left hypochondriac regions should be treated in the same way. Of course only a small portion of the normal stomach can be reached, but should the stomach be in a condition of dilatation a good deal of its surface is brought under the touch.

Many of the foreign manipulators use vaseline or cocoanut oil while operating. The consequent lessening of friction lessens the stimulation of the skin and makes more difficult the proper deep kneading, besides having other inconveniences, such as its uncleanliness and its amazing promotion of the growth of hair. It is occasionally needed when rubbing hairy men, to allow the hands to slip over the hairs without pulling them.

The observation of trained rubbers about the condition of the patient's muscles is very useful, and one learns to depend a good deal upon what they say.

Electricity.—Besides massage for exercise, it is desirable, when possible, although the least necessary part of the treatment, to use a slowly interrupted faradic current to the muscles once a day, going all over the body—an operation which is easily and rapidly done if the operator knows Ziemssen's points. It is best that this should be given by a physician, but, as it consumes much time, the expense to the patient is increased, and for ordinary purposes it may be sufficiently well carried out by a nurse or a masseur. The slowly interrupted current produces a slight contraction of each muscle, and is, besides, in some way not fully understood, of distinct tonic value. After the daily faradization of the muscles has been completed in cases in which the spinal centres seem affected, the use of the rapidly interrupted current through the spinal

cord does good, placing one pole on the nape of the neck and a large electrode upon the soles of both feet, or the ordinary electrode first upon one foot and then upon the other, for a few minutes each. This application should last not less than a quarter of an hour. With these two means, electricity and the kneading of the muscles, we get excessive waste of tissue. We supply this again by excessive feeding, which is made possible by the improved assimilation resulting from the promotion of the digestion and of the circulation brought about by the rubbing and the electricity.

As a trifling practical hint concerning the administration of electricity it may be added that, as many patients fear the very name—some from ignorance, some from recollection of the pain inflicted by its use in rough or incompetent hands—it has become a rule with the writer to begin by passing the electrodes over the skin without making any connection of the wires with the battery. Hysterical patients, already fearful of the results of the application, complain of this excessively. They say that they feel it in their spines or in the tops of their heads, or that they cannot sleep afterward for the excitement which it causes; but if it be kept up for a day or two without regard to the complaints, and they do not then become reconciled, they are then told pleasantly (but without making a jest of it at all) that the complaining has been of the effect produced by two moist sponges, and that no current has touched them. In fact, the current which need be used in most cases is very mild and should not produce any pain.

The enormous amount of food which can be taken by a patient properly rubbed and exercised in this way is shown in the astonishing reports in Dr. Mitchell's and Dr. Playfair's books. Five pints of milk and a pint of soup or other fluid with three full meals is not an uncommon dietary.

It has already been said that the secretion of urine must be especially watched, so that no deposit of urates may escape notice. It rarely happens that nausea is experienced during the taking of this excessive quantity of food, but if it should be, or should any symptoms of dyspepsia appear, a return to strict milk diet for a day or two will usually be sufficient to settle the rebellious stomach.

Medicines.—The subject of therapeutics, or rather the administration of medicines, may now be considered. If the patient show any degree of anæmia, iron should be given early and continued throughout the whole period of treatment. Malt extract may be used as an assistant to digestion and a useful appetizer. There are now so many good extracts that it is hardly necessary to particularize any one. The maximum amount to be given is about three ounces at each meal, taken before or with the food. A cheaper substitute is three ounces of good brown stout with a teaspoonful of dry malt added.

For the many patients who have an idea that they cannot take iron, one of the nearly tasteless salts, like the pyrophosphate or the lactate, can be dissolved in the malt, and very large doses taken in this way—five to twenty grains three times a day.

Blaud's pill is generally well borne, though perhaps a little constipating, but not more so than other forms of iron; and as much as twenty-five or thirty grains of this preparation may be given in a day, watching the passages to see that none of the pills come away undissolved, which will not happen if they be fresh and well made.

If the case be under treatment in the winter-time, cod-liver oil, in doses of half an ounce or less, may be given half an hour or three quarters of an hour after each meal. Dr. S. Weir Mitchell suggests that in those patients in whom it causes nausea it may be used by enema, and will thus have the double advantage of causing the bowels to act regularly and of being absorbed as nutriment. After the patient begins to sit up and move about, some one of the combinations of iron, quinine, and strychnine, or iron, quinine, and arsenic, may be used. Occasionally nervous patients are made more nervous, or even (though rarely) sleepless, by the stimulating effect of the strychnine, and this should not be forgotten in observing them when they are taking doses of this drug.

An excellent tonic, sometimes better borne than the syrupy elixir, is a solution of the hypophosphites of iron, quinine, strychnine, and calcium. The ordinary commercial preparations of hypophosphites usually contain an excessive quantity of phosphates, or are either very sweet syrups or solutions of a decidedly acid reaction. Both are objectionable if taken for a long time. A nearly neutral solution is perfectly possible, and any good apothecary should be able with care to make it.

Special Difficulties.—It may be well to speak separately of some of the difficulties which we encounter in the course of treatment, and of the symptoms which call for special notice. At first, in these cases sleeplessness is not uncommon, and there is no objection to an attempt which is very frequently successful to establish a habit of sleep by the use of hypnotics for a few days, should the milk-diet fail to have a sufficient somnifacient effect. Many nervous patients are extraordinarily rebellious to hypnotics, and some have established a tolerance of large quantities by prolonged use, so that experiments must be made with various drugs in varying amounts. Sulfonal, though uncertain, will often answer well, but must be taken an hour or two before the patient is expected to sleep. The most satisfactory way of giving it is either in small repeated doses of five or six grains each every half hour for two hours before the sleeping-time, or the maximum dose of from fifteen to thirty grains dissolved in boiling water and taken as hot as the patient

can easily swallow it. The bitter taste is objectionable if it is taken in this way, but the effect is very prompt.

Most neurasthenic patients have had insomnia as a symptom, and have been through the list of sleep-making drugs, but it is rare for sleeplessness to continue as a troublesome symptom beyond the first few days, so calming is the effect of the regulated life and quiet of the sick-room. Should they sleep restlessly or wake at frequent intervals, a drip sheet may be used at night in the manner recommended by Ziemssen. The patient, stripped naked, is wrapped in a sheet wrung out of water at a temperature of about 90°, then rapidly rolled in a warm, dry blanket, and left lying upon the bed for a few minutes. Ten or twelve minutes is usually sufficient to recover from the first shock of the cold water and to experience an agreeable reaction. The patient should then be thoroughly dried by lively friction with a warm towel, and put into bed wrapped again in a blanket. As the patient improves in strength or becomes accustomed to this application, the temperature of the water may be gradually lowered, but it should never be excessively cold. The action of this measure is not only without danger, but is to most patients agreeable and both tonic and sedative—useful in toning the nervous system and lowering the excitability of the peripheral nerves. This is generally enough to produce sound and refreshing sleep. If it is not, a light surface rubbing with the hand (not kneading the muscles) may be given by the nurse the last thing before bed-time.

Some patients find the employment of faradic electricity to the spine late at night an aid to sleeping, although quite as many think the application of the rapidly interrupted current so exciting as to make them sleepless if it is given in the evening. Some means must be taken to produce sleep if after the first day or two it does not come of itself, for frequently patients will not gain much until you secure a few good nights' rest for them either with a hypnotic or some of the other means described.

Baths, except the sponging in the morning, as described in the schedule, are not of much service in the conditions we are discussing.

Constipation is an almost invariable accompaniment of rest in bed, and a trouble which one always finds it hard to combat in patients not actively exercising. Should it be obstinate, and not readily overcome by massage of the abdomen or by the fruit which is made a part of the regular diet, a pill of aloes and ox-gall with belladonna, repeated two or three times a day if needed, may be given, or from ten to twenty drops of the fluid extract of cascara sagrada added to the malt extract, once, twice, or three times daily. The extract is more generally effective than the more elegant preparations of cascara, and is not only palliative, but curative, as is shown by the possibility of using it in gradually

lessening doses. The rapidly interrupted faradic current used upon the abdomen, with the poles upon both flanks and gradually moved over the surface, but kept well apart, so that the current may penetrate more deeply, is also serviceable.

For very obstinate cases other methods of stimulating and exercising the abdominal organs are needed in addition to the massage of the abdomen in the manner which has been previously detailed. For instance, let the patient lean forward over the padded back of a chair, resting the hands upon the arms of the chair and the lower part of the chest upon its back. The manipulator, standing behind, clasps the belly with both hands and shakes it rapidly up and down and sideways. This reaches all organs, and has the beneficial effect of horse-exercise, but is more severe. The position absolutely relaxes even the most hysterically contracted abdominal muscles. Of course this mode of procedure is not possible until the patient is strong enough to be up and about.

After years of enemata have ruined the muscular tone of the rectum, or in persistent forms of hysterical constipation, electricity, locally applied, is useful. An electrode with an insulated stem carrying a metal cylinder on the end about one and three-quarter inches long and one-third of an inch thick, is inserted into the rectum and an ordinary large flat electrode placed over the abdomen, while a rapidly interrupted faradic current is passed between them for fifteen to twenty minutes daily. The current should be mild, and it should always be tested before applying it. The electrode is moved slowly about, so as to reach all parts of the wall of the rectum, and may be inserted even eight or ten inches. A nurse can do this with a little instruction.

As a preparation for sitting up, Swedish movements are of use, and afterward are of value in order to keep up the necessary amount of exercise; at first they are passive and then active, and, after the patient is moving about, the movements may be resisted. Especially valuable are the resisted rolling in and out and up and down motions of the thigh with the patient seated. These have a great effect upon the pelvic muscles. (For detailed accounts of these movements the article of Dr. Lee must be consulted.)

A point where a physician new to the management of patients undergoing the rest-treatment will encounter difficulty is when the patient is first called upon to rise from the bed on which she has been recumbent for many weeks. She has been gaining flesh, she has grown rosy, lost the tenderness of her spine or ovaries, her pains, her sleeplessness, and her general nervousness. She is sure to think that she ought to be able to rise directly from the couch and return to her ordinary avocations, unless, indeed, she is one of the inveterate hysterical cases which require to be driven, as it were, at the point of the bayonet to exercise and

movement. It is here that the patient's faith in her physician must be absolute, for when she gets up she will find herself scarcely able to take a step, and too often the mistake is made of allowing or urging the convalescent to do too much or to increase too rapidly the duration of her time out of bed. Every one knows how weak a man feels who has been bedfast, even without acute illness, for days or weeks. It is enough for a beginning to allow the patient to sit up in bed for a few minutes twice daily; then in an arm-chair for ten or fifteen minutes in the middle of the morning (of course without an elaborate toilet), and then for the same space of time in the evening while the bed is being made for her final retirement. These two periods may be increased by daily amounts of five minutes each. When she begins to sit up for half an hour twice daily, the electricity is dropped to three times a week, and active Swedish movements substituted for the passive ones which have been already ordered after the massage. When she has done this for a few days and finds the gymnastics not too fatiguing (and this again is a point to be very carefully watched), resisted movements may be begun and gradually substituted entirely for the massage. After ten days of sitting up the electricity may be stopped altogether. Some rubbing, often only superficial, is agreeable and restful to the patient for several weeks longer. The milk between meals also must be diminished, but need not be stopped entirely, and when the patient has returned to her home she is usually told to continue taking between meals five or six glasses of milk daily.

Active Exercise.—Attempts at walking should not begin until the patient is accustomed to sit up for three-quarters of an hour, and it is not until she can walk freely and steadily about the room that she should leave it. If the need of fresh air be felt, let her sit by the open window carefully covered, and, as her strength increases, begin to practise stair-climbing, commencing with two or three steps down and back, and increasing one step every day; or, should she gain strength fast, a little more exercise may be had. She may now go to drive, and presently to walk. Here, again, is a point at which there is often trouble. Many patients have before partly recovered under various plans of treatment, only to find that when they attempted exercise they again relapsed, and they are constantly filled with fear of active exertion. If the patient is really strong, if her food is well taken and absorbed, her adviser should be discreetly merciless. Not uncommonly a chief reason for disliking walking in the street is the presence of a terror of crowds, a common nervous symptom in some cases.

When the convalescent is able to walk a reasonable distance of four or five blocks, and to take a long drive without fatigue, she should go to the seaside or to the country for a change, to stay three weeks or a month, and thus to test herself and her newly-regained self-control

away from the encouraging presence and moral support of the physician. After this, should it be possible, she may go inland or to the mountains, and thus get the benefit of all that different airs and altitudes can do for her. Each move brings a change of diet, of life, and of surroundings, and after a couple of months spent in this way she should be able to return to her home, and, with common sense as to daily diet, to remain well. Even then a useful precaution to take is to continue a certain amount of rest, especially an uninterrupted hour of entire peace after each meal.

Before her final departure assurance should be had by a careful examination of the eyes that any error of refraction is fully corrected, while any uterine displacement which remains should be mechanically treated.

Duration of Treatment.—As to the total duration of a course of rest-treatment, a definite limit is hard to fix, but a promise should be formally required from the patient or her friends that they will make a trial of at least a month, and in any except the lightest cases it is well on the physician's part to make no promises to let the patient go in less than three months. Of course success may be attained in a very much shorter space of time, and with the fortunate cases which do well from the beginning, where the good-will of the patient is enlisted on the doctor's side and her help aids his efforts, six weeks is a medium period. It should scarcely be attempted in less if any lasting good results are to be obtained—four weeks' absolute rest as described, a week to get up, a week to get out—and even this is hurrying matters a little.

An example is appended of the form of schedule which the nurse is given when the patient is to be put upon full "Rest-Treatment:"

Miss A. B——.
Oct. 1st, 1890. Last menses, May, 1889.
Nurse C. D——. Weight, 111½.
Masseuse, E. F——.
Bed 3.

Cocoa at 7 A. M.
Cool sponge bath with rough rub, and toilet for the day.
Breakfast at 8 A. M., with milk.
Rest an hour after.
8 oz. peptonized milk at 10 A. M.
Massage at 11 A. M.
8 oz. milk or soup at 12 M.
Reading aloud by nurse half hour.
Dinner at 1.30 P. M.
Rest an hour.
8 oz. peptonized milk at 3.30.
Electricity at 4 P. M.
Supper at 6.30, with milk.
Rest an hour.
Reading aloud by nurse half an hour, 8 P. M.
Light rubbing by nurse, with drip sheet, at 9 P. M.

3 oz. malt extract with meals; tonic after meals.

8 oz. peptonized milk with biscuit at bed-time, and a glass of milk during the night if desired.

Laxative (cascara), 10–30 drops p. r. n.

Later, Swedish movements are added after the massage.

Melancholia.—Melancholia was spoken of in discussing the indications, as contraindicating the full treatment by rest, and before concluding it may be desirable to speak fully of the sort of treatment to be used for men or women the subjects of this disorder whom it is not advisable to put upon a regimen of absolute rest. The treatment to be described does not require the entire services of a nurse, although in melancholia cases it will be well, when possible, for the patient to be under the care and direction of an attendant. For these persons even more than ordinary care should be exercised in the selection of the nurse, for upon her tact and the strenuousness with which she carries out the minutest details, and the discretion which she must be allowed to exercise as to holding close to or varying from the prescribed routine, much will depend. The course may be called a partial or relative rest-treatment. In this, as in all cases, it is a good rule to put all orders into writing, and the following is the sort of schedule which the patient would receive:

To breakfast in bed, having first taken or, where an attendant is employed, been given a cool sponge bath while lying down. To lie still for an hour after breakfast, neither reading nor writing. To rise and dress slowly. To go for a short walk or to drive or to do some easy and necessary thing for an hour, like a visit, if he be able. He returns to be rubbed, and must rest after the massage for half an hour or an hour. Before and after the rubbing to take a little extra nourishment—soup or bouillon, a glass of milk, or a glass of koumyss. Then comes dinner, and rest in the same way after it. And rest, as I have said before, means lying still, neither reading, writing, talking, nor being in any way disturbed. In the afternoon he has a couple of hours to do as he pleases. The nurse comes in again, and gives, or the patient performs for himself, some active Swedish movements or light gymnastics. After supper he lies down for an hour, and in the evening is left to his own discretion, with instructions that he must be in bed at a moderately early and regular hour. If sleeplessness be a part of the trouble, he starts to go to bed a little earlier, and the nurse makes another visit for the purpose of giving a light rubbing or the drip sheet, or that combination of both already described.

These cases frequently do well with such a routine continued for many weeks. Some men who have been broken down are able in this way to give a fair portion of their time to business without being absolutely cut off from the activities of life for the purpose of treatment.

SWEDISH MOVEMENTS AND MASSAGE.

By BENJAMIN LEE, A. M., M. D., Ph. D.

The day when the whole duty of the physician was comprised in the prescribing of pills and potions, and when anything beyond this was considered *infra dignitatem,* is happily in the past. The scientific practitioner of to-day considers his the whole realm of nature wherein to seek for the means of curing the maladies and relieving the sufferings of those who place themselves under his care. The imponderables, the gases, physics, mechanics—all the forces of the universe—are laid under contribution to enable him to accomplish his beneficent objects. Man is now regarded not simply as a combination of mysterious vital phenomena or a living laboratory of chemical processes and reactions, but also as a machine of wondrous complexity, obedient to the laws of mechanics, whose several components and constituents are to a great extent governed by the same physical forces as control similar elements outside of the living body.

Among the means belonging to this general class of remedial methods none have attracted more attention within the last quarter of a century than Mechanical Therapeutics; and this has been well deserved. Of one branch of this department of the healing art—namely, the so-called "Swedish movements" and massage—it is the purpose of this article briefly to treat. To trace back the history of the employment of exercises and manipulations for purposes of therapeusis, or to show how in all primitive races such methods, more or less scientifically worked out, are and have been always in vogue, would waste the time of the reader.

Fig. 65.

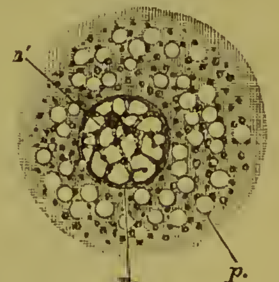


Diagram of a Cell.
p, protoplasm with vacuoles and granules; *n*, nucleus with intranuclear network, *n'*, and nucleolus.

Movement or motion is in modern philosophy the initial of every physical phenomenon or process. Heat, light, electricity, the attractions, are all "modes of motion," to use the generally adopted phrase. In these instances, however, the demonstration of motion is often difficult, sometimes impossible. When we come to the consideration of the living animal, however—the phenomena and processes which we call vital—this dif-

ficulty vanishes. In the primordial cell of every living tissue we are able, with the aid of a microscope, to see this motion going on. This cell is the unit and exponent of life, both in its origin and its perpetuation. We observe the incessant movement of its contents within and through its walls by constant endosmose and exosmose. Irregularity or retardation of this motion constitutes the condition to which we give the name "disease." Cessation of this motion is "death." "Health" is that condition of the individual in which the movements of the cell-contents of all the tissues are normally carried on. It is the

FIG. 66.

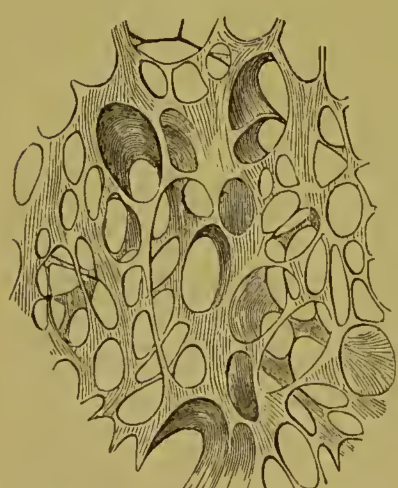
Blood-corpuscles developing within Connective-tissue Cells.

h, a cell containing diffused hæmoglobin; *h'*, globular masses of colored substance in protoplasm, within which also are numerous vacuoles; *h''*, a cell filled with colored globules.

function of ordinary muscular movement, such as is necessarily used in the daily avocations of life or instinctively used in obedience to the imperative demand of the muscular sense, to maintain this normal movement of the cell-contents.

It is the function of "remedial" or "localized" or "Swedish" movements and massage to restore this normal movement of the cell-contents when it has become retarded or otherwise disarranged. This therapeutic method, therefore, addresses itself to the very beginnings of life and nutrition, building up the frame anew from the foundation; and hence it is that its reconstructive results are of so permanent a character. Founded upon the strictest inductions of science, and in harmony with the most recent revelations of physiological investigation, it stands upon a plane of certainty in theory and of precision in practice not attainable by the more empirical systems of the materia medica.

FIG. 67.



A view of a portion of Areolar Cellular Tissue, Inflated and Dried, showing the general character of its larger meshes; magnified twenty diameters.

Remedial movements and massage must necessarily be considered together for two reasons: First, because they pro-

duce their effects upon the system through the same channels and in the same manner; and, secondly, because in the vast majority of cases the best results of one cannot be obtained without a recourse to the other. In the most vigorous patients the finer processes of massage are needed to supplement the coarser effects of active movements; and, on the other hand, the sufferer who requires massage is rarely so feeble that, at least, passive movements of the extremities may not be employed with additional benefit.

Swedish Movement Cure.

It is generally admitted that remedial gymnastics owe their renaissance to a Swede, Petter Henrik Ling, a fencing-master in the University of Lund, in the early part of the present century, and their development into an acknowledged system of therapeutics to the fostering care of the Swedish government. The perpetuation of these facts in the name of the system is therefore nothing more than an act of justice. It is sufficient to remind those who object to the expression "cure" as savoring of charlatanism that "cure" (Latin *cura*) does not mean "healing," but simply "care" or "treatment."

The institutions in Sweden where a knowledge of the Swedish gymnastic systems, pedagogic (physical culture) and remedial, can be acquired are the Royal Central Gymnastic Institute at Stockholm and the Universities of Upsala and Lund. At the Stockholm school, where only a limited number are admitted annually, the course of study was formerly two years, but has now been extended to three, the last year being principally devoted to practice. The medical students generally take a few months' course of practical instruction in the movement cure to enable them to write a prescription for movements and to apply them personally if occasion arises. In every city of any importance in the kingdom there are found one or more gymnastic establishments to which physicians can send their patients. Such institutions are always under the supervision of a physician. Three years since a law was passed requiring any one desiring to establish himself as a kinesipathist to obtain a permit from the National Board of Health, and placing every such establishment under the control of the city physician.

In the year 1865, Dr. Gustaf Zander opened an institution in Stockholm under the name of the Mechanico-Therapeutic Institute, in which the movements were administered by means of machinery driven by steam. This method has acquired so much popularity that there are now two such establishments in Stockholm and one in each of other two Swedish cities, and in several places in Germany.

At the United States Centennial Exposition in 1876, Dr. Zander

had a considerable amount of his apparatus in operation, constituting an exhibit of great interest and value. At that time the apparatus of his institution at Stockholm consisted of 67 machines—viz.: 17 machines for active arm movements; 18 machines for active leg movements; 9 machines for active trunk movements; 23 machines for passive movements. The passive movements are worked by a steam-engine of about five horse-power.

By means of these machines the following movements can be executed: 1. Flexion of the arm (at the elbow-joint); 2. Extension of the arms (at the elbow-joint); 3. Twisting of the arms (at the shoulder- and elbow-joints); 4. Flexion of the arms (at the shoulder-joint); 5. Extension of the arms (at the shoulder-joint); 6. Flexion of the hands; 7. Extension of the hands; 8. Adduction of the arms; 9. Abduction of the arms; 10. Upper and forearm extension of the entire arm directly upward; 11. Upper and forearm flexion of the entire arm directly downward; 12. Flexion and extension of the fingers; 13. Flexion of the legs (at the knee-joint); 14. Extension of the legs (at the knee-joint); 15. Twisting of the legs outward; 16. Twisting of the legs outward and inward; 17. Flexion of the legs (at the hip-joint); 18. Extension of the legs (at the hip-joint); 19. Flexion of the feet; 20. Extension of the feet; 21. Adduction of the legs; 22. Abduction of the legs; 23. Hip-knee-foot extension and flexion; 24. Hip-and-knee flexion; 25. Hip-and-knee extension; 26 Foot-rolling; 27. Flexion of the trunk (in the lying position); 28. Flexion of the trunk (in the sitting position); 29. Extension of the trunk (in the standing position); 30. Extension of the trunk (in the lying position); 31. Twisting of the upper trunk; 32. Twisting of the lower trunk; 33. Lateral flexion of the trunk; 34. Extension of the neck; 35. Shaking of different parts of the body; 36. Chopping of different parts of the body; 37. Tapping on the head; 38. Kneading of the abdomen; 39. Kneading of the arms; 40. Rubbing of the feet; 41. Rubbing of the hands; 42. Rubbing of the back; 43. Rolling of the trunk; 44. Swinging of the trunk; 45. Balancing of the trunk; 46. Expansion of the chest,—in all forty-six different movements, most of which may be modified in various ways to suit different purposes.

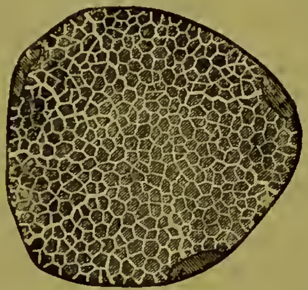
An institution using this machinery has been for several years in successful operation in London. Machines for this purpose have also been invented by Drs. George H. Taylor and Charles Fayette Taylor of New York, and successfully used at their institutions in that city. There are also two or three private medical offices in Philadelphia where apparatus is utilized for the administration of remedial exercise, but without the use of steam. Such apparatus is simply to be regarded in the light of a labor-saving device, enabling a physician

who makes mechano-therapy a specialty to treat a large number of patients with few assistants. The only form of passive exercise which can be given more efficiently by machinery than by the hand of the operator is vibration. For this purpose a machine is vastly superior.

Movements for a therapeutic purpose owe their efficacy to the action of muscular contraction in facilitating the circulation of the fluids of the body, the blood, the lymph, and the areolar fluid. This is of course apart from their purely mechanical value in overcoming deformities.

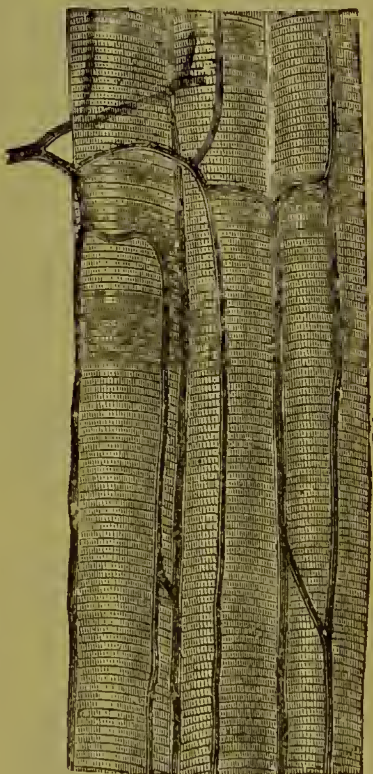
A muscle is not simply an organ of locomotion. It is a reservoir of blood (Fig. 68). All the processes of nutrition, tissue-metamorphosis, destruction, and reconstruction, molecular death, and cell-renewal are

Fig. 68.



Section of a Muscular Fibre showing Areas of Cohnheim.

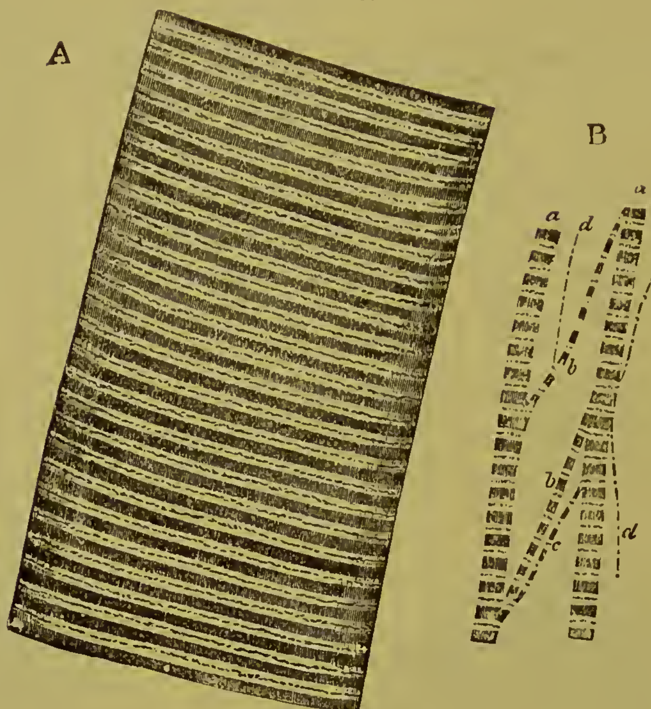
Fig. 69.



Capillary Vessels of Muscle.

carried on in muscular tissue to a greater extent than in any other. To the proper performance of these vital processes the movements of the fluids are essential. Every time that a muscle contracts it forces the blood out of its venous capillaries into the venules, and so on into the venous trunks (Fig. 69). Every time that a muscle relaxes it invites the blood into its arterioles and arterial capillaries, and supplies the incessant demand for oxygen and cell-food. It is a matter of scientific demonstration that heat is evolved, electricity generated, and chemical reactions produced by and during muscular contraction. A free acid (probably lactic) is produced at the expense of the destruction of the hydrocarbons. The formation of carbonic acid is greatly increased. The various substances containing oxygen are decomposed with greater rapidity, and thus made available for tissue-building, and it must be remembered that all general affections involving the processes of nutrition and leading to morbid conditions of the blood depend to a great extent upon suboxidation in the muscle-cell.

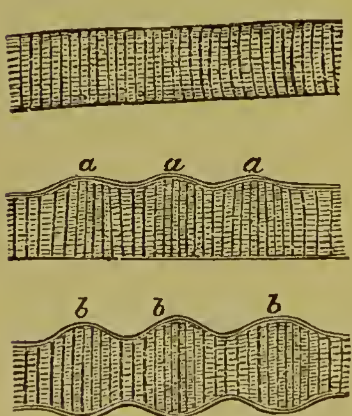
Fig. 70.



Muscular Fibre.

A. Portion of a medium-sized human muscular fibre (magnified nearly 800 diameters). B, separated bundles of fibrils, equally magnified; *a*, *a*, larger, and *b*, *b*, smaller collections; *c*, still smaller; *d*, *d*, the smallest which could be detached (Kirkes).

Fig. 71.



Muscular Fibre contracting, showing condensation of tissue (G. H. Taylor).

Two possibilities, therefore, at once suggest themselves: First, that by the systematic use of the entire muscular system we can improve the nutrition of the whole body; and, secondly, that by acting on certain sets or groups of muscles we can produce a revulsive or derivative action, and thus relieve engorged and congested organs. Further, by developing the muscular tissue to its full capacity we diminish undue nervous irritability. Nothing more need be said to demonstrate the applicability of this method to the relief of all *chronic functional disorders*.

Viewed from a therapeutic standpoint, two modes of contraction are recognized in muscular tissue—viz. *concentric* and *eccentric*.

When the muscle-cells, making a contractile effort, shorten themselves in the direction of the long axis of the muscles, and thus shorten the muscle itself, the contraction is concentric. When the muscle-cells, making a contractile effort, are overcome in this effort by a superior force, and are actually elongated in the direction of the long axis of the muscle, which is itself therefore lengthened, the contraction is eccentric.

Eccentric movement takes place in a muscle under two conditions—natural or physiological and artificial. Natural when the contractile

Fig. 72.

Flexion of the Forearm.
Operator resisting, the biceps contracting concentrically.

force is put forth to just such a degree as to steady the limb moved by the voluntary contraction of its antagonist, thus assuring co-ordination and preventing jerking or spasmodic action. Hence in every natural movement of a sound limb we have one set of muscles contracting concentrically and producing the desired movement, and the antagonistic set of muscles contracting eccentrically, and thus limiting and steadying the movement. If while a muscle is making the effort at concentric contraction we apply such force to the extremity of the limb as to cause it to move in the opposite direction, we produce an artificial eccentric contraction. What is the condition of the antagonist to the muscle which is in this process of artificial eccentric contraction? Obviously, it is not contracting concentrically, because the will-power is exerted in exactly the reverse direction. Nor is it contracting eccentrically, because the force which is applied to its opponent takes away the necessity for the co-ordinating resistance. Hence it must be in an

absolutely passive condition, neither contracting nor relaxing under the influence of the will, but simply gradually shortening, by virtue

FIG. 73.

Forced Extension of Forearm.
The biceps contracting eccentrically.

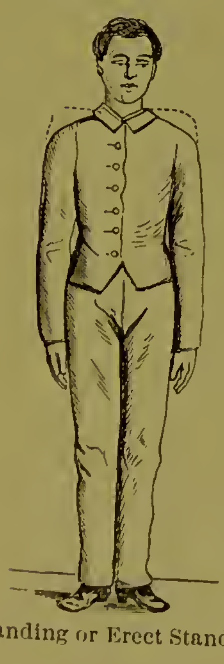
of its elasticity, as its extremities are approximated. All the nerve-force, both volitional and instinctive, is at the disposal of the muscle which is undergoing artificial eccentric contraction. This muscle is therefore receiving the largest possible supply of nerve-force or stimulus at the expense of the least possible outlay to the central nervous system, while at the same time the blood is invited into it by reason of its enforced relaxation. Hence this is the form of contraction which most efficiently aids molecular change in the muscular tissue and promotes its nutrition. At the same time, as it is an essentially active movement of great power, care must be taken that the patient does not exert too much strength, especially if in a condition of lowered vital-

ity. The concentric contraction, on the other hand, is that which aids most directly the onward flow of the fluids in their respective vessels.

The division of movements or exercise into *active* and *passive* is too well known to require description. There is, however, another distinction with which the profession is not so familiar—namely, that of *single* and *duplicated* movements. A movement is called single which is effected by the patient without the aid of an assistant or of machinery. Hence all single movements are active movements. They are usually performed without apparatus, although very light dumb-bells or wands may be employed. When a movement is given with the aid of an assistant, either resisting an effort on the part of the patient or compelling the patient to make a motion which he is endeavoring to resist, this is called a *duplicated movement.* Much of the skill of a practised operator consists in exactly adapting the amount of force which he employs in these duplicated movements to the capacity of the patient, and in teaching the patient to make the movement with such an expenditure of force as shall stimulate the muscle without exhausting its nerve-centre.

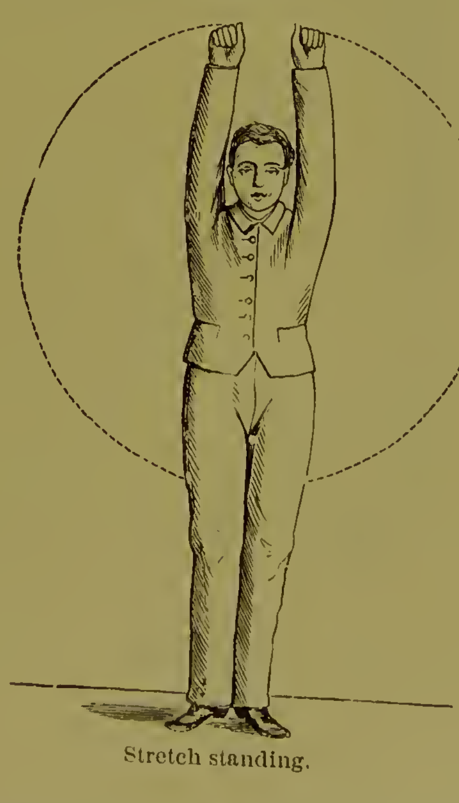
In accordance with the character and degree of motion which the various joints permit in the parts or limbs in which they are sit-

Fig. 74.



Standing or Erect Standing.

Fig. 75.



Stretch standing.

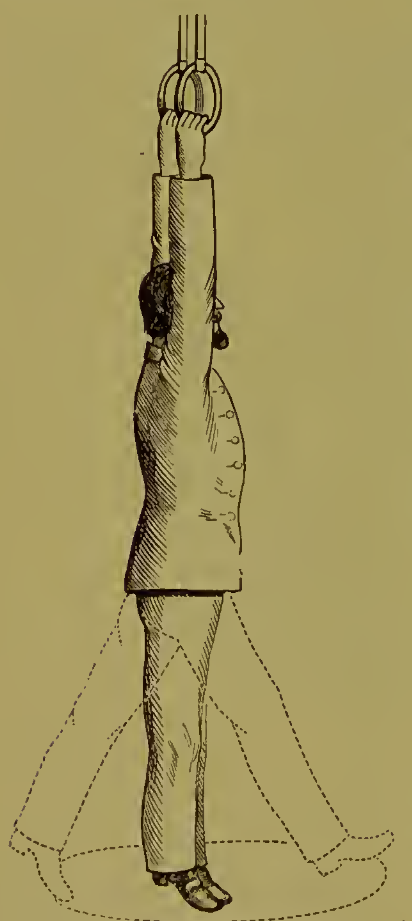
uated, and the groups of muscles which are concerned in the production of the motion, the several movements are divided into flexions and

extensions, abductions and adductions, pronations and supinations, rotations or twistings, and, finally, bendings. These are again specifically described as of the head, trunk, extremities, or subdivisions of the latter. To these may be added stretching, a passive movement of great importance.

In the nomenclature of the different movements it is customary to begin with the posture or attitude in which the patient should be placed in order to make the movement most efficient with the least expenditure of nerve-force.

The principal postures are *standing, kneeling, sitting, lying,* and *hanging.* These primary postures may be again subdivided, but it is unwise to attempt too great a refinement either in attitudes or movements. The Swedish works on this subject are overloaded with a cumbrous nomenclature which wearies the student and reader without offering any corresponding advantage. They are intended to be descriptive, and any physician can invent descriptive titles for himself.

Fig. 76.



Hanging.

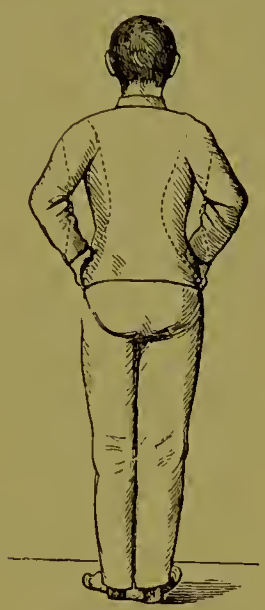
For the various positions of the arms and legs the terms *forward, backward,* and *sidewise* or *side,* and *high* and *low,* naturally suggest themselves. There are two quite appropriate terms for two positions of the arms often required—*shelter,* in which one or both hands are placed with the palms resting on the top of the head; and *wing,* with the hand on the hip and the elbow extended. When only one extremity is used in any posture the position is called *half,* Thus, *shelter sitting* means sitting erect with the palms of the hands resting on the top of the head. *Right half wing standing* signifies standing erect with the right hand resting on the hip and the elbow outstretched. This, it will be observed, is a very decided economy in the use of language, and is a saving of time in either speaking or writing.

Stretch signifies complete extension of the upper extremity in any direction.

Stride, the thighs widely separated in either the standing, sitting, or lying position. Various signs have also been introduced to make

descriptions still more concise, but these, like the signs in stenography, are purely arbitrary, and it is unnecessary to do more than refer to them.

Fig. 77.



Wing standing.

Fig. 78.

Stride wing standing.

Following the posture is written the part which is to be moved, as head, wrist, thigh, and then the movement which is to be performed

Fig. 79.

Wing standing, leg abducting.

Fig. 80.

Wing crook standing.

and the direction in which it is to be made. Thus, shelter stride sitting, trunk twisting to left, describes a movement in which the patient

sits erect, with the hands crossed over the top of the head and the knees embracing the corner of a couch in order to steady the pelvis, while the operator, standing behind, takes hold of the right elbow with the right hand and places the left hand in a supporting manner against the left side posteriorly. The operator, then making use of the extended arm as a lever, slowly twists the upper portion of the trunk toward the right, at the same time instructing the patient to resist the movement. When the movement has reached its extreme limit, the patient is then ordered to rotate the trunk in the opposite direction, which is done against the resistance of the operator. When it is desired, a particular note may be placed on a prescription, as to whether the operator is to make the movement against the patient's resistance or the reverse, by means of the letters *p. r.* and *o. r.*, signifying *patient resists* or *operator resists*.

Fig. 81.

Wing standing, side bending.

The posture is a matter of much moment, as it ensures rest to such portions of the muscular system as we are not at the moment desiring

Fig. 82.

Wing standing, trunk rotation.

Fig. 83.

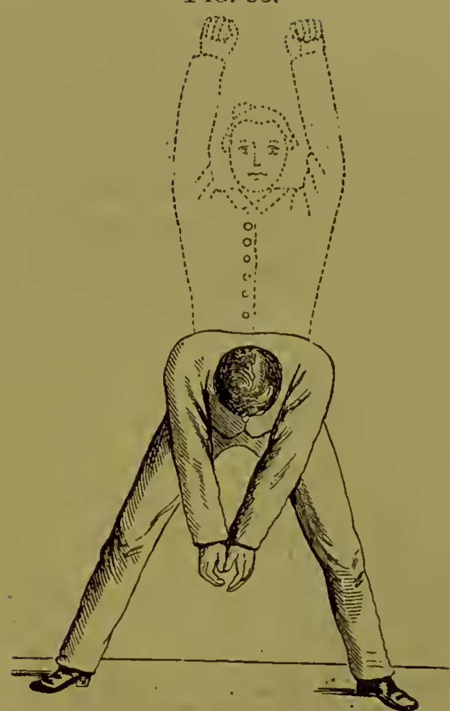
Wing standing, forward and backward trunk bending.

to call into play, thus husbanding nervous energy, or throws a certain group of muscles into stronger action, or fixes the origin of particular muscles, or overcomes distortions, or throws certain muscles into a condition of absolute relaxation.

Fig. 84.

Wing standing, knee bending or curtseying.

Fig. 85.

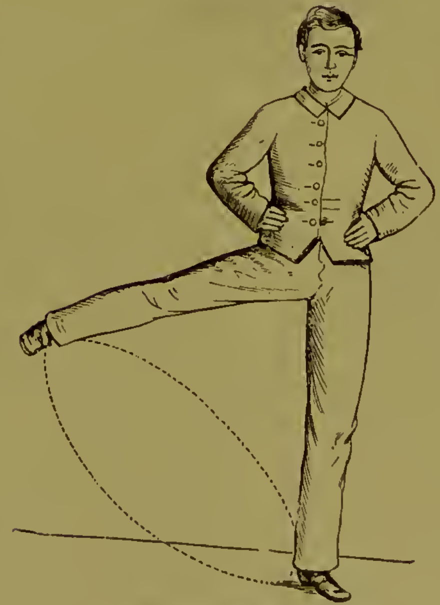


Stride standing, forward bending, or hewing.

Fig. 86.

Half wing, half stretch, standing; forward bending, or sawing.

Fig. 87.

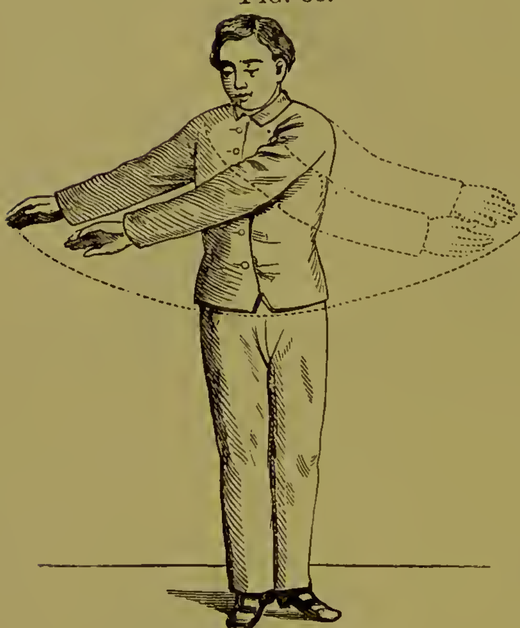


Wing standing, leg circling.

The following is a list of the principal positions of Ling, as given, with slight modification, in Melio's *Manual of Swedish Drill.* These are all active, single movements, standing or kneeling :

		Figure
Primary Positions.	Position or attention position, or standing	74, 88
	Wing standing positions	77, 80, 87
	Neck rest position	—
	Closed standing position	—
	Wing toe stand position	—
	Stride wing stand position	78
	Wing walk position	—
	Neck rest stride stand position	—
	Stretch stride stand position	85

Fig. 88.



Standing, arms circling.

Fig. 89.

Wing, outward lunge position.

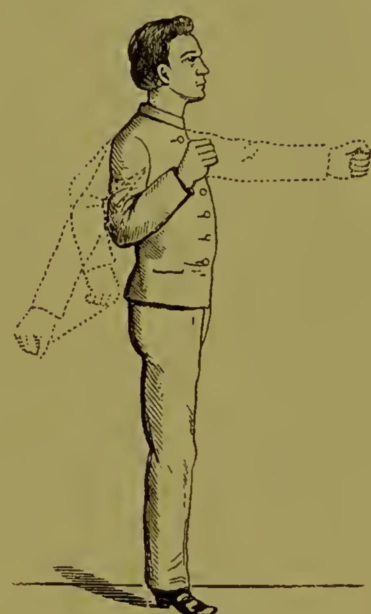
Foot, Leg, and Balance Positions.	Stretch walk toe stand position	—
	Wing stand knee bend position	84
	Wing crook stand position	79
	Wing stand lateral bend positions	81, 82
	Stretch stride stand trunk forward bend position	85
	Tense knee bend, or sitting, position	84
	Neck rest knee bend position	—
	Wing outward lunge position	89
	Stretch pass, or forward lunge, position	—
Neck, Trunk, and Abdomen.	Wing stand forward trunk bend position	83
	Wing stand, rear trunk bend position	83
	Half-stretch stand, lateral bend, position	—
	Stretch stride, stand trunk twist, position	—
	Stretch walk, rear trunk bend, position	—
	Neck rest, stand trunk twist bend position	—
	Wing, knee stand, rear trunk bend position	—
	Stretch, knee stand, rear trunk bend position	—
	Stretch, half knee stand, rear trunk bend position	—
	Prone falling or side leaning rest position	—
	Half-stretch, side prone falling, position	—

		Figure
Fingers, Arms, and Shoulders.	Stretch position	75
	Half, or alternate stretch positions	—
	Backward (forward, upward, or sideward) stretch position	91
	Upward arm bend position	—
	Forward arm bend position	—
	Outward (upward or downward) fling positions	90

FIG. 90.

Outward stand, outward fling, position.

FIG. 91.



Standing, backward, forward, stretching.

The foregoing selection of terms and movements is merely intended to serve as a key to the numerous positions derived therefrom.

MASSAGE.

Massage may be defined to be the communication of motion to the tissues of the body from an external source for therapeutic purposes. This at once distinguishes it from *movements*, in which, as already said, the motion takes place through the joints and is extended to entire extremities or the trunk; and it also separates it from general *exercise*, which implies in addition volition, and therefore the communication of motion from an internal source.

Let it be clearly understood that neither the Swedish movements, as we consider them, nor massage, nor the two combined, have for their object what is known as physical culture or physical education. That has for its aim—and a most laudable one it is—the symmetrical development of the comparatively healthy human being, muscle and nerve, brain and stomach, and belongs to the domain of hygiene or preventive medicine. The system which we are considering, on the other hand, is purely remedial. This, however, does not prevent the employ-

ment for therapeutic purposes of many of the specific single movements, such as are used in general training. In point of fact, the hygienist has borrowed them from the therapeutist, who first reduced them to a system.

Massage may be *immediate*, when the motion is communicated directly to the part operated on by the hand of the operator, or *mediate*, when some mechanical contrivance is made use of to produce the motion. The word massage comes to us from the Greek through the French language, and signifies kneading, the manipulation of the tissues being somewhat like those of a baker kneading dough; but as the term "kneading" is employed to describe one of the principal modes or varieties of massage, it avoids confusion to retain the French word to designate the general system. Further than this, the term has now an accepted position in the medical vocabularies of all nations. A male operator is therefore a *masseur*, and a female operator a *masseuse*, while the patient is *masséed* (pronounced *massayed*) not *massaged*. The proper pronunciation of the word is *massäzh*, like the first syllable of *azure*.

All the procedures may be placed under four general heads, thus greatly simplifying the nomenclature. These are *stroking* (the effleurage

Fig. 92.

Deep Stroking with Finger-tips.

of the French writers), *kneading* (petrissage, malaxation), *friction* (massage à frictions), and *percussion*.

Stroking is performed over large areas of surface with the palm of

the hand or its radial border (the thumb being abducted), and over smaller surfaces with the pulps of the fingers or sides of the knuckles. The degree of pressure varies with the sensitiveness of the part operated on and the indication to be met, but it should always be sufficiently firm to act upon the areolar tissue beneath the skin and the superficial veins. Except in very rare instances its direction should be centripetal, toward the heart. Every movement of any kind is concluded with a stroking. As the hand which has completed a stroking returns to the

FIG. 93.

Deep Stroking with Finger-pulps.

FIG. 94.

Deep Stroking, or Squeezing.

point from which it started it touches the surface very lightly. In some conditions it may be necessary to use the thumb or the finger held nearly perpendicular to the surface, in order to penetrate deeply between groups of muscles. It is sometimes needful, when the tissues are very rigid or the person obese, to reinforce the operating hand by pressing heavily upon it with the other. The stroking should follow the long axis of the limbs and the direction of the muscular fibres, from the extremities toward the trunk and from insertion to origin. The position of a limb undergoing this manipulation should generally be that of semiflexion, in order that neither the muscles nor the fasciæ may be in a state of tension. The speed of the stroking must be regulated by the general condition of the patient. In the beginning of a

course of treatment the movements should be moderate and gentle, increasing in rapidity and force as the patient becomes accustomed to them. In a weak, nervous, excitable patient they should be less rapid than in one of greater strength or more phlegmatic temperament. In treating the hand the strokes will be carried from the ends of the fingers to the wrist-joint. These may be given at the rate of from ninety per minute to twice that number. The forearm will be stroked from the wrist to the elbow, and the arm from the elbow to the shoulder in one sweep. Both hands may be used, the one returning as the other makes the stroke. And similar areas may be covered in the case of the lower extremities. In the former each hand may make the stroke from seventy-five to a hundred and fifty times a minute, and about the same rate may be used between the ankle and knee; but from the knee

Fig. 95.

Stroking from Ankle to Knee.

to the hip they will scarcely reach one hundred, or upon the back more than seventy.

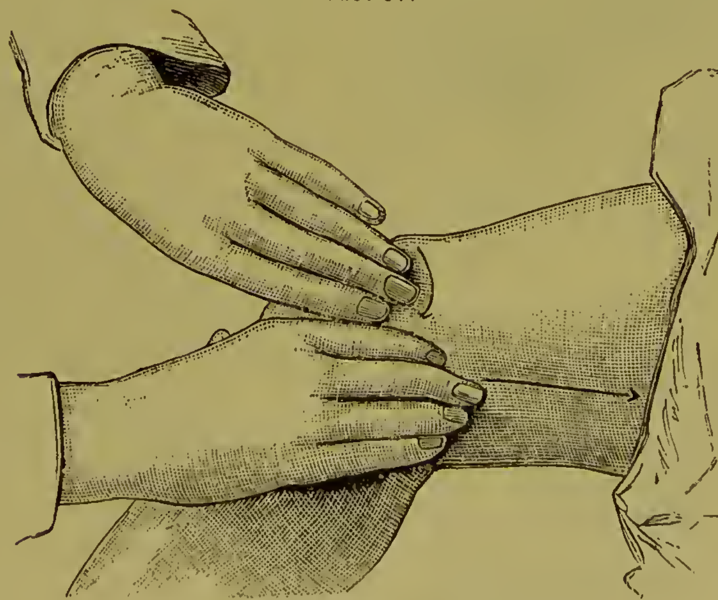
Friction.—This consists in forcible circular rubbing over small areas. It may be performed with the full hand or with the tips of the fingers, preferably the latter. It should be constantly alternated with heavy centripetal stroking over very small surfaces, either with the same or the other hand. The thumb is constantly brought into

FIG. 96.

Tendon-stroking with Knuckles.

requisition for this purpose. These two distinct movements, the one rotary and the other in the direction of the axis of the limb, may be

FIG. 97.



Friction of Knee-joint (after Murrell).

made simultaneously with the two hands by an experienced operator. It will be understood, then, that friction, in its technical sense as a

Fig. 98.

Friction of Ankle-joint (after Murrell).

mode of massage, is an entirely different procedure from what is ordinarily termed friction or rubbing. The latter simply irritates the skin and stimulates the superficial cutaneous capillaries.

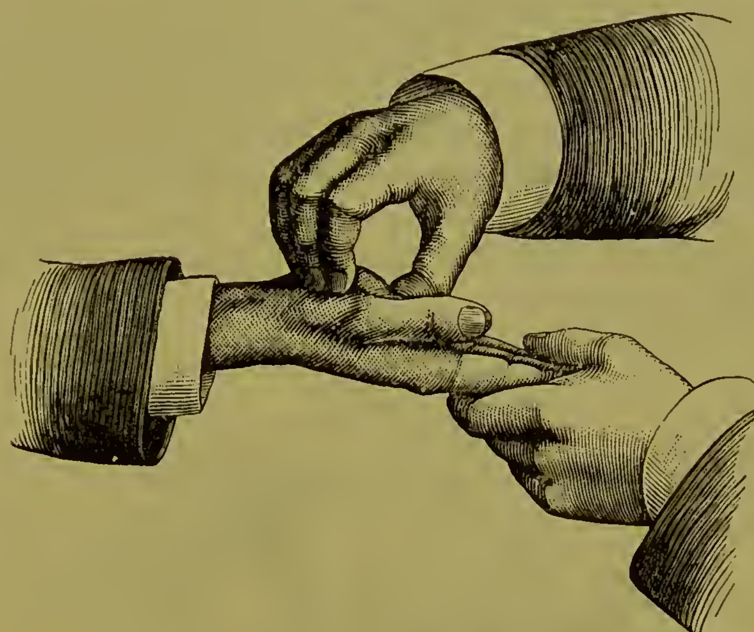
Fig. 99.

Shoulder-kneading.

Kneading is performed by grasping a muscle or group of muscles or other portion of the tissue, either with both hands or between the thumb and fingers of one hand, and subjecting it to firm pressure, rolling and squeezing it between them or against the underlying substance or organ, as, for instance, a bone. In treating the arms or the leg below the knee the limb is usually grasped by the two hands, one making pressure on the anterior and posterior, and the other on the lateral, surfaces. An amount of pressure must be maintained so that the fingers shall not move over the surface of the skin, but shall carry the skin with them, causing it to move over the muscle. It is essential except in the case of abdominal massage, and

there it is partly true. By alternate pressure and relief from pressure the blood and other fluids are rapidly expelled and as rapidly absorbed

Fig. 100.



Hand-kneading.

from and into the muscular tissue. It should always be begun at the extremity of a limb and continued upward toward or to the body, being

Fig. 101.

Strong Kneading of the Arm.

careful that every part of the limb is treated. The thumb and fingers are to be held well apart in administering it, and their movement should

be a slightly rotary one. In manipulating very small areas the tips of both thumbs are used, and where we desire to reach single superficial nerve-trunks, as in the scalp, the backs of the thumb-tips. A valuable method of kneading as applied to the limbs is the manipulation known as *fulling,* so named from the motion used by fullers or bleachers in rubbing linen between their hands. It consists in holding the limb between the palms of both hands, with the fingers fully extended, and making a rapid to-and-fro movement with each, the result being that the limb is rolled back and forth between the hands. The alternations of pressure and relaxation are thus made more rapidly than in the method already described.

Fig. 102.

Arm-fulling.

Kneading cannot be executed as rapidly, however, as stroking. Indeed, a certain duration of the successive pressures is quite essential to its thorough efficiency. That of the phalanges of the fingers may be accomplished at the rate of from seventy-five to one hundred and fifty pressures per minute; of the arms, with somewhat less speed; of the legs, from sixty to ninety; and of the thighs, from forty to eighty; while on the broader surfaces of the back and abdomen nearly a second will be required for each movement.

Another important modification of kneading is *vibration.* It consists in making the alternate successive pressures and relaxations, which are the characteristic features of that procedure, with very great rapidity. This may be done with the hand, but requires considerable strength, steadiness of nerve, and long practice. It is accomplished much more effectively by means of some form of machine, of which several have been devised. The reflex, thermal and electrical effects of such a rapid agitation of the tissues are remarkable. The sensation produced is very

similar to that caused by a mild current of electricity. It is a powerful stimulant to secretory action, an excitant of the capillary circulation,

FIG. 103.

Deep Pressure with One Knuckle—Vibration.

and an awakener of dormant nervous energy. The same mechanical contrivance which produces the vibrations may, by a simple change of

FIG. 104.

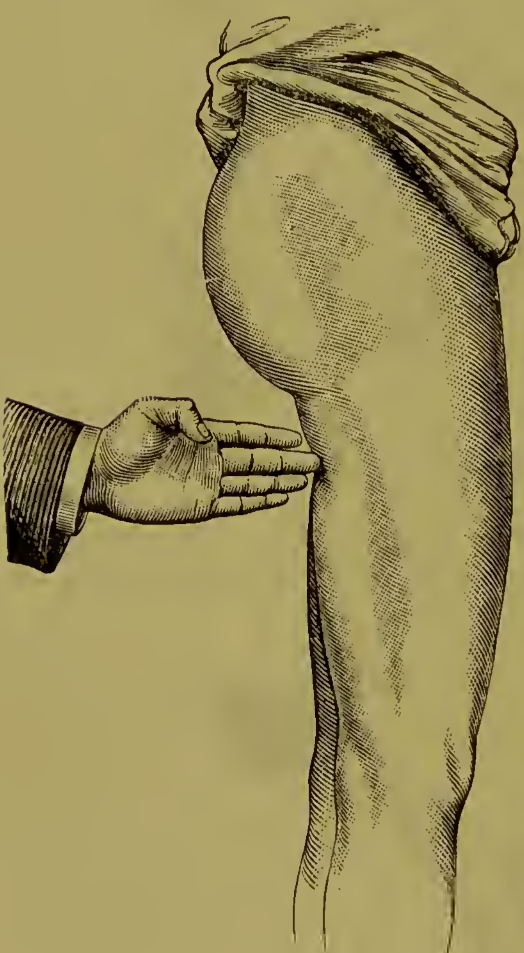
Deep Pressure with Two or More Knuckles—Vibration.

connections and terminal appliances, be made to perform kneading and rubbing.

Midway between kneading and percussion, but properly classed with the former, is *pressure.* This consists in making firm pressure with a small surface, as the tips of the fingers held stiffly or the knuckles. It is used especially when we desire to reach deep-seated nerve-trunks.

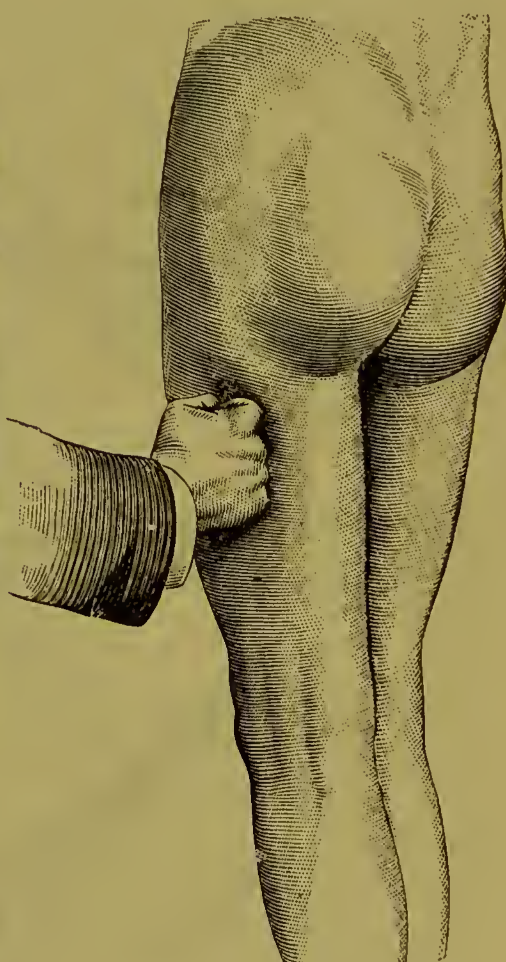
Percussion signifies, of course, striking or beating the surface. We may use either the hand or an instrument constructed for the pur-

FIG. 105.



Pointed Vibration or Thrusting (Deep Pressure).

FIG. 106.

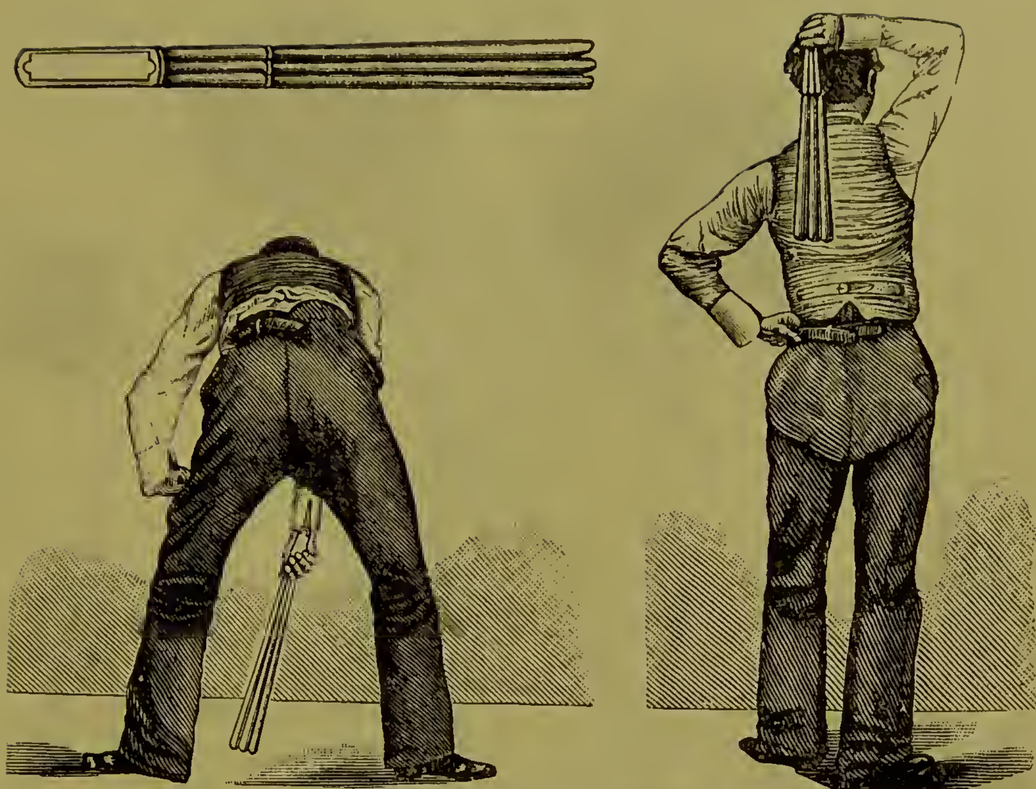


Fist Vibration or Pressure.

pose called a percussor or muscle-beater. Several such are in use, generally made of rubber tubes or balls attached to handles. The best known of these is Klemm's, invented by C. Klemm, director of a gymnastic establishment in Riga. Granville of London has devised an electric percussor, similar to the instrument used by dentists in filling teeth, by means of which percussion may be applied with great rapidity and graduated force over very small surfaces.

Immediate percussion may be modified to a greater extent than any of the other forms of massage simply by delivering the blow with different parts of the hand. The palm of the hand may be used, when

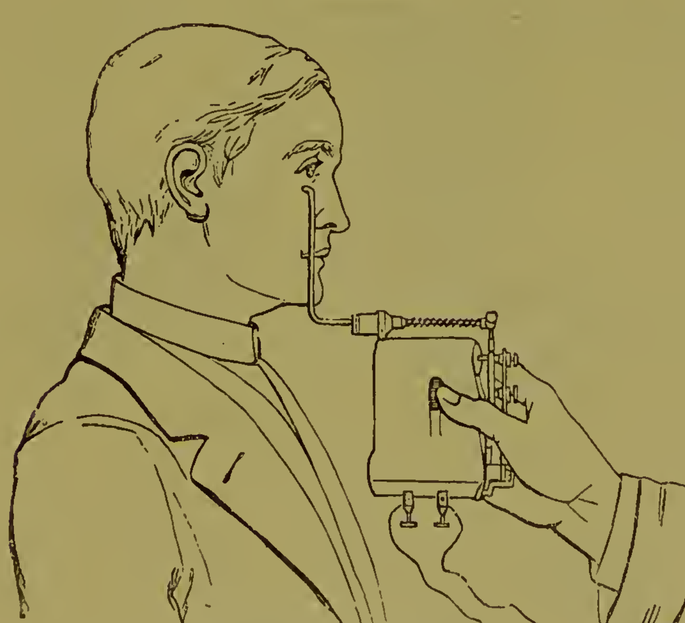
FIG. 107.



Use of the Klemm's Muscle-beater.

the operation is called *clapping;* the ulnar border, when it is denominated *chopping;* the tips of the fingers held stiffly, true *percussion;*

FIG. 108.



Granville's Electric Percussor.

the closed fist or the dorsal surfaces of the two last phalanges of the fingers held rather loosely, constituting *whipping* or *flagellation.* This

Fig. 109.

Back Chopping.

Fig. 110.

Neck and Shoulder Chopping.

form of percussion should be delivered from the wrist with the greatest possible rapidity and only moderate force.

Fig. 111.

Whipping or Flagellation

The masseur will economize his own force and add to the comfort of his patient by judiciously selecting the areas which may be advantageously included in a single procedure, and also by studying the relative positions of himself and his patient. Dr. Douglas Graham

Fig. 112.

Thigh Chopping.

considers that from the wrist to the elbow and from the elbow to the shoulder are suitable extents of surface to be worked upon with ease. As the lower limbs are larger than the upper, the lateral and posterior aspects from ankle to knee will form a convenient territory, while the lateral and anterior will constitute another.

The operator should stand facing the patient, and, after having completed the manipulation here, without stopping the strokes turn his

back to the patient and continue the operation on the anterior and lateral aspects, each thumb following the other with tolerably firm pressure on the anterior tibial group of muscles.

The same systematic division of surface may be made above the knee as below, but the operator will find that with his back to the patient he will on the whole treat this region with the greatest ease and best results. From the base of the skull to the spine of the scapula forms another convenient region for downward and outward semicircular stroking, and from this latter boundary to the base of the sacrum still another over which one hand can sweep, while the other approaches it, operating on the glutei muscles from their insertion to their origin. On the chest we may conveniently work over each of the pectoral masses, proceeding from insertion to origin.

The same author suggests that in kneading "each group of muscles should be systematically worked upon; and for this purpose one hand should be placed opposite the other, or when the circumference of the limb is not great one hand may be placed in advance of the other, the fingers of one partly reaching on to the territory of the other, so that two groups of muscles may be manipulated at the same time with grasping, circulatory spiral movements, one hand contracting as the other relaxes, the greatest stretching of the tissues being upward and laterally, and on the trunk, forearms and legs, away from the median line." He finds it well to go over each surface gently and superficially before doing the manipulation more thoroughly and in detail. In kneading a leg of considerable size the posterior and lateral aspects will be treated as one region; "the stretching of the peroneal muscles away from those of the anterior tibial region" will require a distinct manipulation, and "rolling of the tissues away from the crest of the tibia" will demand a third. Above the knee one hand will grasp the adductors, while the other embraces the quadriceps extensor, and the alternate contraction and relaxation of the hands will be made in such a way as to stretch these two groups of muscles away from the line of the femoral artery. Proceeding then to the posterior femoral region, the sides of the limb posteriorly will be embraced by the hands, while the fingers reach around to the posterior surface, meeting behind. In manipulating the back, "the muscles on each side of the spinal column can be rolled outward with the ends of the fingers, and the supraspinous ligament can be effectually treated by transverse to-and-fro movements. The ends of the fingers and part of their palmar surfaces should also be placed on each side of the spinous processes, and the tissues situated between them and the transverse processes worked by up-and-down motions parallel to the spine."

Cervical Massage is most effectively performed in the following

manner: The patient should stand with the head slightly thrown back and the shoulders depressed. This is the position in which the neck is

Fig. 113.

Neck Massage (Gerst's method).

most readily reached by the operator, and it affords the broadest surface for manipulation. The patient should be enjoined to breathe quietly, regularly and deeply, in order to promote the flow of blood from the head to the heart and lungs. The special form of massage to be used here is stroking. It may be divided into three acts: The operator stands directly facing the patient, placing the ulnar borders of his upturned palms in the cervical fossæ, so that the little fingers shall pass along the horizontal ramus of the lower jaw, and their ends shall reach the mastoid processes of the temporal bones. While the ulnar borders are now moved downward, both hands rotate, turning the radial borders upward and inward toward the head until they reach the positions first held by the ulnar borders. In this way the entire palm of the hand has been brought into contact with the surface of the neck, while at the same time downward pressure has been made upon the right and left common jugular veins, and upon the pneumogastric and cervical sympathetic nerves, by means of the thumbs; and the superficial veins and lymphatics of the postero-lateral regions have been reached by the palmar surfaces of the fingers. The movement is carried down to the supraclavicular fossæ. When this point is reached the hands are rapidly moved back to the starting-point, lightly grazing the surface; and then the movement is repeated.

If the patient is too feeble to stand, he may sit on a high chair, with the head somewhat bent backward and the upper part of the

chest exposed. The masseur, standing now behind instead of in front as before, places the fingers of both hands in the groove beneath the lower jaw and strokes rapidly downward and outward with a moderate degree of pressure, the thumbs not being called into requisition.

In the case of little children the patient may lie upon the nurse's lap, the head being allowed to fall somewhat backward. The operator then seats himself in front of the child and joins the fingers of both hands over the cervical vertebræ. The thumbs reach forward as far as the larynx, and so the entire neck is grasped. Downward strokings are now made with the thumbs from the border of the jaw to the

Fig. 114.

Neck Massage (method of Béla Weiss).

clavicles, pressure being made at one time on the jugular veins and at another on the sides of the larynx.

Abdominal Massage.—Another region which is deserving of especial reference as regards the mode of its manipulation is the abdomen. Abdominal massage may be performed in several different ways. The first requisite to its efficient performance in most cases is a moderately relaxed condition of the abdominal muscles. To secure this the trunk should be slightly elevated in a reclining posture and the legs semiflexed, with the feet firmly supported. The patient must now be instructed to breathe quietly and regularly, in order not to allow him to stiffen the abdominal muscles. In some patients this tendency is extremely difficult to overcome, and it is surprising what a rigid barrier they are

able to interpose between the contents of the cavity and the hands of the masseur. Laisné's method, which is much followed, is simple and tolerably effective. It is thus described: "The masseur lays his hands on either side of the abdomen, and executes a firm but not violent double rubbing movement, one hand ascending as the other descends, the principal pressure being made by the thenar and hypothenar prominences, and not extending higher up than the transverse colon or lower down than the ileum. On reaching the cæcum the colon is to be followed along its ascending, transverse, and descending portions successively. This manipulation is to be repeated two or three times."

Reibmayr's procedure is somewhat more complicated, but also more scientific and probably more efficient. It is composed of four distinct

Fig. 115.

Abdominal Massage—first manipulation (Reibmayr).

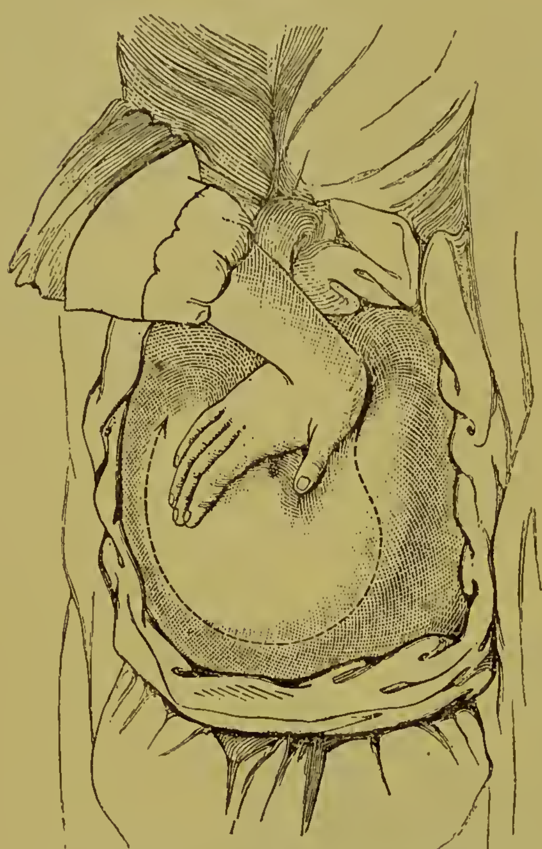
manipulations, which are employed according to the indications, either singly or combined. If the operator desires especially to stimulate the peristaltic action of the intestines, he uses the first and second. If, however, he wishes to act mechanically on their contents, he adds to the second the third and fourth, or employs all three simultaneously.

The first manipulation consists in tracing circles around the umbilicus with the tips of the fingers of the right hand, the end of the thumb lying sideways on the surface, and serving as a movable centre for the motion which is taking place through the joints of the finger and hand. By enlarging the circles and making the pressure alternately light and heavy the power of the application is increased. This

manipulation is irritating to the nerves, and many feeble or nervous persons cannot endure it. For such persons the—

Second manipulation may be substituted. The finger-tips remaining inactive, the circles around the umbilicus are described with the palm of the hand, which is extended as strongly as possible, being held nearly at right angles with the arm. The force is now exerted principally by the heels of thumb and of the little finger. This manipulation adds a certain amount of mechanical action to the reflex stimulation, is effective, and not disagreeable to nervous patients.

Fig. 116.



Abdominal Massage—second manipulation (Reibmayr).

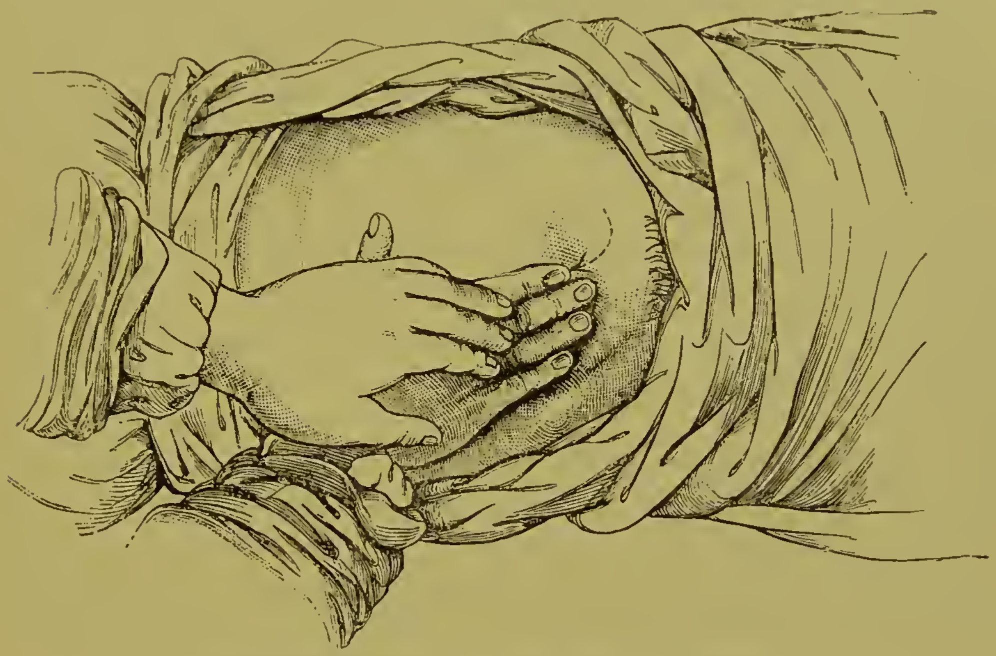
When it is desired to act directly upon the intestinal contents, the manipulations should be directed especially to those portions of the intestinal tube in which fæcal accumulations are apt to occur—namely, the cæcum and the sigmoid curvature of the rectum. The two following methods may then be relied upon:

Third Manipulation.—The right hand is to be applied flat to the right inguinal region, the fingers being directed downward. The left hand is placed on top of the right, pressing strongly on its first phalanges. With the two hands in this position *stroking* is performed from below and within, upward and outward, following the course of the cæcum and ascending colon as high as the borders of the ribs. The hands then pass lightly down over the navel, producing a slight reflex stimulation. The pressure of the left hand upon the right must be so made as to prevent the fingers of the latter from flexing, and thus maintain the opposition of the entire hand throughout the manœuvre.

The fourth manipulation is applied on the opposite side of the abdomen, the tips of the fingers being directed toward the spleen, and the double pressure being applied in the same way. The direction of the motion is reversed—from above and without downward and inward. As the pelvis is approached the fingers should be made to

penetrate as deeply as possible. The operator may kneel, sit, or stand as best suits his convenience in relation to the position of the patient.

FIG. 117.



Abdominal Massage—third manipulation (Reibmayr).

In standing he is of course able to use much more force with less expenditure of strength than in the other postures.

Before leaving the *technique* of massage there are two or three questions which naturally suggest themselves to every physician who attempts to treat his patients in this manner, and which may appropriately be discussed here:

First: What should be the frequency of the séances? This must depend much on the nature of the affection under treatment. As a rule, they should be not less frequent than daily. It is a mistake to suppose that the treatment is so exhausting that a day of rest is needed after each day on which massage has been administered. If this is the case, it shows that the manipulations have been either too severe or too long continued. Twenty-four hours is ample time for recuperation in any condition in which massage is justifiable. An interval of double that extent will only retard the recovery and make the treatment more irksome. There is generally a sense of relief and refreshment after the application, which makes the patient look forward anxiously to the arrival of the next séance. In no case should it be employed less frequently than every other day. Such a use of it is not only time and money thrown away, but may do positive injury and bring discredit on the system. Any one who asks to have massage once a week for the relief of any disease shows an entire ignorance of the laws which govern the effects of exercise on the human body. The rest of

the one day in seven will be of inestimable value to the masseur and of no injury to the patient. The effect of the manipulations of the six preceding days will not have had time to wear off before the impression is renewed on the eighth. The only exceptions to this rule are where the affection is a very painful one or where insomnia is a prominent and distressing feature of the case. In either of these instances the patient may petition for a Sunday séance, which should be granted if possible.

If the treatment is in most cases to be given as often as once a day, there are many instances in which it may be given more frequently with the greatest possible advantage. In convalescence from fevers and acute inflammations recovery will be accelerated by massage given twice daily, late in the forenoon, and about nine o'clock in the evening in order to promote sleep. In sprains treatment twice a day is also indicated. In cases of general paralysis and all forms of muscular atrophy it may be given three times a day with decided advantage. In *general massage*, and especially when the abdomen is to be kneaded, at least an hour should elapse after a meal before the operation is commenced. Otherwise the blood and the nervous energy may be diverted from the stomach to such a degree as to interfere with digestion.

Second: What shall be the duration of each séance? Here the requirements and limitations of each individual case must be considered. If the treatment is given two or three times daily, each application will be shorter than if it is used but once a day. General massage demands from thirty to forty minutes. A sprain may be well and thoroughly manipulated in fifteen minutes. Patients are very apt to make the mistake of supposing that because a treatment of half an hour will produce a certain amount of benefit, one of an hour will produce twice as much.

There is a common impression abroad that when a professional masseur is called in he owes his patient a full hour's services at each visit, and the patient feels that he is not getting his money's worth unless he has the full hour. In point of fact, in the majority of cases of general disease all the manipulating that is done beyond forty minutes is either useless or harmful. There is such a thing as an overdose of massage as well as of opium or calomel. Some authorities go so far as to say that four minutes are sufficient in the majority of cases. Abdominal massage should not be continued more than ten or fifteen minutes. Infantile paralysis demands at least half an hour. When, in the treatment of any particular case, a number of special movements are indicated, as in chronic rheumatism or lateral curvature of the spine, the time must of course be extended.

Third: Should massage be given directly upon the naked skin or with the intervention of clothing? Those who suppose that they convey

some mysterious power of their own, such as magnetism or electricity, to the patient insist strenuously on the importance of contact of the hand with the skin. Others, as Schreiber, consider that the action on the tissues is purely mechanical, and that therefore it is better, both for protection against cold and from motives of delicacy, to have the surface covered with a light flannel garment. More than a single thickness of some quite thin texture certainly interferes very seriously with the efficient and intelligent performance of the manipulations.

Both for massage and for movements the clothing should be of such a character as to allow perfect freedom of motion on the part of the patient, and complete access to every part of the surface by the operator. Hence the ordinary dress must be removed and a special dress substituted. For women a gymnasium costume, consisting of loose or Turkish trousers and a jacket or a blouse not quite reaching the knee, made of some light woollen material, is the most appropriate, and a light slipper without a heel should be worn. It is almost impossible to manipulate properly over a linen garment, as it slips under the fingers. For men an ordinary suit of underclothing or a jersey suit answers every purpose.

As a rule, it may be said that in general massage, where large areas are traversed, and where we desire to act on the deep-seated tissues, the intervention of a single thickness of some light material will not prove a serious obstacle, and, should the masseur have a moist hand, may make the manipulation easier for him and more agreeable to the patient. But when we are working over limited surfaces, as around joints, along the course of tendons, or over swollen glands—when we desire to produce superficial counter-irritation and a derivative action toward the skin, or by light stroking to soothe the nerves and produce sleep—better effects are obtained by treating the bare skin. The majority of patients, women as well as men, prefer to have the limbs treated uncovered. Massage of the abdomen may always be performed through the clothing unless the patient especially desires otherwise.

Fourth: In working directly upon the skin is it desirable to use a lubricant? Here there is a great difference of opinion amongst practical manipulators. Perhaps the majority of writers advise the use of an oil before massage. Schreiber came to the conclusion that so far from being an assistance, in many manipulations it rendered the operation more difficult. Graham considers that the necessity for the use of an unguent indicates want of skill on the part of the operator. Wherever it is necessary to use strong friction over a limited area for a long time, as in the treatment of sprains, inflamed joints, tendo-vaginitis, and the like, the use of lard, vaseline, cocoa-butter, or some such fatty substance will be found useful in preventing abrasion of the sur-

face. If we have in view the reflex, thermal and electrical effects of massage, we dispense with these substances. They are especially desirable when we wish to promote the absorption of extravasations, and the removal of old deposits and effusions into joint-cavities. The value of inunctions in wasting diseases, especially in conjunction with massage following the Turkish bath, constituting what is technically known as the "Roman bath," is not overlooked, but this is quite a different matter, and should more properly be eonsidered under the title of "Baths." In a general way, it may be said that when we are employing this system for surgical affections the use of an unguent is appropriate, but when using it for medieal eases it is not called for. Of eourse, the intervention of sueh an agent would be a direct obstacle to stimulation of the surfaee eireulation and inviting the blood into the capillaries of the integument, and must be avoided when our object is primarily derivative. In treating ignorant or ineredulous patients the use of an oil or unguent may sometimes be desirable in eommanding eonfidenee and as a *placebo.* This is espeeially the case in massage of the eye. In dry massage the operator must be earcful when using frietion not to use too mueh foree, and especially not to allow it to degenerate into rubbing, otherwise he may produce exeoriations whieh will interrupt the treatment and frighten or disgust the patient.

Fifth: Shall the surfaee upon whieh especial attention is to be bestowed be shaved? This will rarely be necessary. Of eourse, when the treatment is administered over elothing this question eannot arise. In using frietion about joints the parts on which the most of the heavy work must be done are usually almost devoid of hair. The cases in whieh this expedient must be resorted to are more apt to be sprains, in whieh it is neeessary from the outset to employ a great deal of heavy eentripetal stroking the entire length of the limb, in order to promote the absorption and speedy removal of the products of inflammation. In these instanees, if the limb is unusually hairy or the skin excessively delicate, a eareful use of the razor, with extreme eaution not to remove any of the epidermis, may be expedient.

Sixth: What amount of force shall the masseur use? This must be proportioned to the nature of the case, the age of the patient, the sensitiveness of the part, and the temperament of the individual. The experieneed manipulator aequires great sagacity in judging of all these points. He likewise learns to diseriminate between aetual suffering and imagined pain as the result of his manipulations. He finds that a pressure or movement which, anticipated by a nervous, hysterical, wayward, timid, or caprieious patient, is reeeived with every manifestation of acute agony, will, if he sueceeds in engaging the attention of the patient or fixing it on some other part of the body, be borne almost uneomplainingly. When he finds, as a result of excessive zeal,

black and blue spots all over his patient's limbs, he may consider it wise to moderate his energy. These little extravasations are usually the result of too forcible massage administered with too little flexibility of the wrist, and are not calculated, as Schreiber considers, to shorten the duration of the treatment or aid in the cure of the case. The more expert the manipulator becomes, the more rarely will he be called upon to see such marks. It is true that if we have to deal with fungous or spongy tissues or masses of exudation of a low degree of organization, it is difficult to avoid the rupture of small vessels. But these cases are rare, and, except in the instance of individual idiosyncrasy in which there is a hæmorrhagic diathesis strongly marked, if we simply desire to disgorge blood- and lymph-channels in order to remove imflammatory products, it is entirely unnecessary to use sufficient force to produce ecchymotic spots. It is needless to say that they often create an impression unfavorable to the masseur and to the continuance of his care of the case in the minds of the sufferer and of his friends. Moderately firm, gentle, and well-distributed massage is in most cases both more acceptable to the patient and easier for the operator. It will of course be understood that after a course of massage has been persisted in for a time the tissues will have acquired a firmness and resistance which they did not at first possess, and will therefore be less liable to these accidents. It is especially at the commencement of the treatment of a case that caution is requisite in this particular.

Physiological Effects.—In order to understand the therapeutic applications of massage it is absolutely necessary to know something of its influences on the system.

Not the least among the advantages of massage as a remedial agent is the fact that its mode of action is physiological, not pathological. It removes a disease-process, not by substituting for it another abnormal or toxicological process, but by directly substituting a condition of healthy action. Hence, if properly performed in cases in which it is indicated, there need be no fear of unpleasant after-results, such as often follow the prolonged administration of drugs, familiar examples of which are found in the abuse of opiates, of hypnotics, of stimulants and of laxatives. The effects of massage may be arranged under four heads—namely, *mechanical*, *reflex*, *thermal* and *electrical*.

The *mechanical* effects are by far the most important, but the others should not be overlooked or forgotten. They consist, as briefly suggested at the beginning of this article, in stimulation of the interchange of cell contents under the influence of alternate pressure and relaxation; a quickened movement of the blood in the capillaries, especially in the muscular tissue; increased activity in the movement of the areolar fluid; acceleration of the currents of both blood and lymph in their

respective channels; stimulation of the absorbents; removal of obstructions and concretions from ducts; increased secretion of the various organs; the promotion of the peristaltic movement of the intestinal canal; and increased respiratory action and capacity.

Numerous experiments by Ludwig, Weiss, Krause, and others have demonstrated that the principal agent in carrying on the circulation of the lymph, apart from the aspirative effect of respiration, is muscular contraction. If a small glass tube be inserted into a large lymph-duct in a dog's leg, so long as the animal remains perfectly quiet no flow of lymph takes place, but as soon as the paw is moved an abundant stream of lymph gushes forth. In the same way, if we allow the paw and limb to remain at rest, but make use of centripetal stroking and kneading of the leg, the flow again takes place. If, now, inflammation be artificially produced in the paw, and either passive motion or massage be applied, the lymphatics being divided above, lymph will begin to flow. The lymphatic glands, which are not in the least susceptible to electrical stimulus, are also powerfully affected by muscular motion and by the different methods of massage. The experiments of Von Mosengeil are equally pertinent and interesting. They consisted in injecting a thick solution of India ink into different joints in rabbits. Certain of these joints were then subjected to massage, while others were left untouched. In the joints which were thus treated the swelling which resulted from the injections rapidly subsided, while it remained present for a considerable length of time in the others. The animals having been killed, the joints were opened. In those which had been kneaded no ink was found, while in those which had been allowed to remain quiet it was found mixed with the synovial fluid. The muscles of the thighs were then examined, and numerous and widely disseminated black deposits were found in the areolar tissue in those limbs which had been subjected to treatment, and none in the others. A transverse section of the upper part of the thigh of a limb which had been manipulated disclosed deposits of the coloring matter in the intermuscular connective tissue and staining of the crural muscles. In the other limbs the muscles remained of a bright-red color. Still further, the glands of the manipulated limbs above the joints were stained intensely black, and the lymphatics leading to them had the appearance of black cords. No deposits whatever were found in the lymphatic system of the untreated limbs. We are therefore warranted in asserting that massage promotes absorption through synovial membranes, and that pathological products thus absorbed are taken up by the lymphatics.

The effect of massage upon fluid in the peritoneal cavity was studied by Reibmayr and Hoffinger in the following manner: The subjects of the experiments were healthy rabbits. The abdomen was shaved, the

animal carefully weighed, and then tightly secured to a table in such a way as not to interfere with respiration. It was then anæsthetized; a fold of the abdominal wall was raised between the thumb and finger in the left hypogastric region, and a fine exploratory trocar was inserted into the abdomen. Tepid water (35° C.) of a measured quantity was then injected. The animal was unbound, and either left to itself or subjected to massage at regular intervals. At the expiration of a fixed time it was killed by section of the medulla oblongata. The abdomen was then carefully opened, the condition of the peritoneum noted, and the fluid remaining in the cavity measured. The quantity absorbed was calculated from this, and then compared with the entire weight of the body. From these experiments Reibmayr considered that the following deductions could fairly be made:

"1. Under ordinary conditions the normal peritoneum absorbs a relatively large amount of a bland or slightly irritating fluid injected into its cavity; that is to say, 4.57 per cent. of the weight of the animal in one hour, and 7.40 per cent. in two hours.

"2. The absorption takes place with the greatest rapidity immediately after the injection, and, if the animal remains at rest and without the operation of external influences, sinks during the second hour to nearly one-half of the amount absorbed in the first hour; that is to say, from 4.57 per cent. of the weight of the animal in the first hour to 2.83 per cent. in the second.

"3. General massage of the abdomen invariably increases the peritoneal absorption, and to the following extent: in one hour to 9.09 per cent., or 4.52 per cent. of the weight of the animal; and in two hours to 10.29 per cent.; that is, 2.89 per cent. over and above what it would have been without massage.

"4. During abdominal massage the absorption of free fluid from the abdominal cavity is accelerated to the greatest degree during the earlier part of the application, being stimulated to such an extent that in the first hour 9.09 per cent., or 4.52 per cent. of the weight of the animal, is absorbed; in other words, exactly twice as much as without the use of massage. In the second hour, on the other hand, in spite of the massage, only 1.20 per cent. was taken up, not more than half as much as without massage, and only a trifle more than one-seventh of the amount absorbed in the first hour with massage, or about 1.63 per cent. of the weight of the animal less than in the second hour without massage."

The *reflex*, or purely nervous, effects of massage are obtained by *light stroking* and *percussion*. The former produces results which can only be explained on the supposition that it acts as a stimulant to the reflex system of nerves, the force used not being sufficient to account for any change on the mechanical theory. It induces contraction of

the arterioles, and consequent acceleration of the circulation. In some as yet unexplained way it has a remarkable power in soothing pain, which must be due to a reflex impression on the nerve-centres of sensation. Applied along the sides of the neck, it reaches in this manner the great controller of organic life, the vagus nerve and great sympathetic system. Applied over the abdomen in rapid circular strokes, it produces a marked effect upon the peristaltic wave in the intestinal tube. Over the chest, and especially along the insertions of the diaphragm, it noticeably increases the depth of respiration. Tickling is a manifestation of this power, long familiarity with which has led us to overlook its scientific significance. As pointed out by S. Weir Mitchell, we have an ocular demonstration of the fact in the reflex contraction of the cremaster muscle on gentle stroking of the inside of the thigh. The fact that percussion of a muscle or tendon will create a sudden spasmodic contraction of the muscle has long been known. So well satisfied is the mind of the profession as to the character of these contractions that they have been given the name of "tendon reflexes." The most notable of these is that known as the patellar-tendon reflex, the diagnostic value of which is universally recognized. "Muscle reflex" would probably be a more correct appellation. The fact is, that sudden sharp percussion on any muscle in any part of its length will produce a reflex contraction in it. That of the patella is the most easily appreciated, simply from the fact that it is indicated by a long index, the entire leg and foot below the knee. In very thin persons percussion of the pectoralis major will produce a wave of contraction which can be distinctly seen travelling across the chest. This is so noticeable that it has been set down by some observers as a sign of phthisis pulmonalis. It simply indicates a degree of emaciation which permits the muscular fibres to be readily traced beneath the skin.

The experiments of Goltz show that the reflex effects of percussion are not confined to the voluntary muscles, but extend also to involuntary muscles and contractile tissues. This is especially noticeable in percussion of the abdominal walls. The value of the following observation by the last-named investigator cannot be over-estimated: He found that if the heart of a frog were exposed, and percussion were then made upon the uninjured abdominal wall with a blunt implement, the pulsations of the heart gradually became reduced in frequency, until finally it altogether ceased to beat. This stoppage of the heart's action he considered to be due to a true reflex inhibition through the intervention of the vagus. When the inhibitory action induced by vigorous and somewhat protracted percussion began to pass off and the heart again began to beat, an entirely new form of contraction developed itself. Instead of the auricle and ventricle becoming strongly distended with blood during the diastole, and the systole then

forcing the blood in great volume into the aorta, causing it to dilate and lengthen out, the heart received very little blood during its period of relaxation, remaining collapsed and pale, and a very trifling amount of blood was forced into the aorta during the systole. The dimensions of the auricles underwent little or no change, and the venæ cavæ were almost empty. Wounded arteries in the extremities scarcely bled at all. In brief, the condition of the circulation was very similar to that which would ensue after a colossal hæmorrhage. If the animal were left to itself, after a time the pulsations became more pronounced, until finally they returned to the normal standard. This alteration in the heart's action must depend upon an alteration in the active contractility either of the heart or of the blood-vessels. If of the heart, the alteration must be either in the nature of increased or of diminished activity. The author demonstrates satisfactorily to himself by a series of experiments that it is owing to neither of these conditions in the heart itself, or, rather, that these conditions in the heart would lead to no such result. We must look to the condition of the vessels, then, in explanation of the phenomenon. If we subject an animal to the percussion experiment, and then open the abdominal cavity, we shall find the abdominal vessels, especially the veins, dilated and distended with blood. This plethora is the result of a relaxation of their walls produced by the mechanical irritation. After a time the vessels regain their tone under the influence of the central nervous system, and the heart then beats as strongly as before. The sudden dilatation of these vessels may be compared to a suddenly-developed aneurism. The tension which is necessary to propel the blood forward to the heart through the great vessels ceases. But little blood, therefore, enters the heart during its diastole, and it works painfully, like a pump without water. We must conclude, then, that the circulatory disturbances induced by abdominal percussion depend upon a relaxation of the abdominal vessels, and that the restoration of the normal condition is brought about by the active contraction of the same vessels. Further experiments demonstrate conclusively that the contractility of the veins is under the control of the central nervous system primarily, and secondarily of the abdominal ganglia.

In consequence of the powerful influence which this apparently simple manipulation is capable of exerting upon the physiological processes of the body, we must, in its administration, carefully consider the force, number, and rapidity of the blows, the duration of its application, and the locality upon which it is applied; and we shall also find occasion to vary greatly the modes of its application in accordance with the various affections for which we employ it.

As we can, by means of brief and light percussion, develop, first, a contraction, and then, by a continuance of percussion of increasing

severity, a dilatation, and finally a paralysis of the vascular system, so percussion will produce a similar train of effects upon the sensory nervous system. For instance, we observe that if we percuss over a sensitive nerve an increase of pain at first occurs, which, however, rapidly diminishes, then entirely disappears and gives place to complete loss of sensation. The more sensitive the nerve the less force and time is required to reduce it to this condition.

The *thermal* effects of massage and movements are almost too apparent to need scientific demonstration. Every one is familiar with the fact that both muscular contraction in the form of ordinary exercise and simple friction develop bodily heat in a striking degree. Friction, indeed, develops heat to the degree of combustion in inanimate materials, and chafing of the hands and feet to restore warmth is an expedient familiar to us all. Exact observations as to the power of massage in this direction have been made, and are not without interest. S. Weir Mitchell, in his valuable essay, *Fat and Blood, and How to Make Them,* notes what has been the experience of all masseurs, that he has "frequently seen the strangely cold limbs of children suffering from infantile paralysis gain from six to ten degrees Fahrenheit during an hour's massage." In nervous and hysterical women he often notices at first a slight fall in temperature, which is of course attributable to emotional causes. This subsequently gives way to a tolerably constant rise. He has found the most notable rise in "persons who, owing to some organic disease, have a natural liability to great changes of temperature." The following illustrative tables show these facts very clearly:

"Mrs. J——, at rest on the usual diet. Manipulation at 11 daily:

Before Massage.	After Massage.	Before Massage.	After Massage.
100°	100°	$99\frac{2}{5}$°	100°
100	$101\frac{1}{5}$	100	100
$99\frac{2}{5}$	$99\frac{4}{5}$	$99\frac{4}{5}$	100
$99\frac{4}{5}$	100	$99\frac{4}{5}$	100

"Miss P——, æt. 24, hysteria:

Before Massage.	After Massage.	Before Massage.	After Massage.
$99\frac{1}{4}$°	$99\frac{1}{4}$°	$100\frac{1}{5}$°	$100\frac{2}{5}$°
$98\frac{1}{4}$	99	$100\frac{2}{5}$	$101\frac{2}{5}$
$98\frac{1}{2}$	$98\frac{1}{4}$	$100\frac{2}{5}$	$100\frac{3}{5}$
99	$99\frac{3}{4}$	$100\frac{3}{5}$	100

"Mrs. L——, a very thin, feeble, and bloodless woman, æt. 29 years:

Before Massage.	After Massage.	Before Massage.	After Massage.
99°	100°	$98\frac{2}{5}$°	$98\frac{4}{5}$°
$98\frac{1}{2}$	$99\frac{1}{5}$	99	$99\frac{4}{5}$
98	$98\frac{2}{5}$	100	$100\frac{1}{5}$
99	100	99	$99\frac{4}{5}$

"Mrs. P——, æt. 31, feeble and anæmic, nervous, slight albuminuria and chronic bronchitis. Liable to fever, 3 P. M.:

Before Massage.	After Massage.	Before Massage.	After Massage.
$101\frac{3}{5}°$	$102°$	$100\frac{3}{5}°$	$101\frac{3}{5}°$
100	$100\frac{4}{5}$	$100\frac{2}{5}$	$99\frac{4}{5}$
99	$99\frac{4}{5}$	$100\frac{3}{5}$	$100\frac{2}{5}$
100	101	$100\frac{3}{10}$	$100\frac{9}{10}$
$99\frac{2}{5}$	$100\frac{1}{5}$	$99\frac{1}{5}$	$99\frac{4}{5}$
$99\frac{4}{5}$	$100\frac{3}{5}$		

These temperatures were taken always before 4 P. M., and at intervals of three days. Her morning temperature was usually 99° to $99\frac{4}{5}°$, and in the evening, nine to ten o'clock, it always rose to 100°, 101°, and at times to 102°."

The slight fall in temperature following massage in certain individuals is probably due to increased activity of the sudoriparous glands and consequent surface evaporation.

Kirke, in his *Handbook of Physiology,* says: "The fact that the manifestation of muscular energy is always attended by the evolution of heat and the production of carbonic acid has been demonstrated by actual experiment; and when not actually in a condition of active contraction, a metabolism not so active, but still actual, goes on, which is accompanied by the manifestation of heat. The total amount set free by the muscles, therefore, must be very great; and it has been calculated that the amount of heat produced by muscular activity supplies the principal part of the total heat produced within the body."

Massage of the abdomen alone, without movements, has been found to diminish the temperature of the extremities.

The effect of massage in heightening the surface temperature of the part immediately operated on is much more striking than is its effect on the whole body-temperature, as observed by Mitchell. T. Stretch Dowse of London, in his lectures at the West End Hospital for Nervous Diseases, showed a child suffering from infantile paralysis in whom, the temperature of the ward being 64° F., that of the inner part of the leg was below 70° F. After ten minutes' kneading the temperature had risen 17° F. Twenty minutes' kneading the evening before had increased the temperature to $94\frac{1}{2}°$ F.

The *electrical* effects of massage result partly from the development of surface heat, partly from surface friction, partly from the attrition of the muscular fibres and cells, partly from nerve-stimulation, and partly from chemical action. How far these delicate currents are influenced by the electricity developed in the hand of the operator, and to what extent they influence tissue-metamorphosis, are questions still to be solved by experiment. But, that massage stimulates the electrical contractility of a muscle has been proved by many observers. Zabludowski demonstrated that kneading restored the contractile power of

muscles exhausted by the rhythmical application of maximal induction currents, while simple rest without massage had very little restorative effect. Von Mosengeil, at the request of Murrell of London, applied an electrode to the motor point of the external popliteal nerve, "and gradually reduced the strength of the current until it failed to produce any contraction in the muscles; he then masséed the limb for two or three minutes, after which the current, which had previously failed to elicit a response, produced vigorous contraction." Mitchell, in his work on *Injuries of Nerves*, says: "I have several times noticed that muscles which were previously sluggish, after being thoroughly kneaded would contract far more readily *when faradized*." Graham similarly observes: "My own observations, repeated almost daily, teach me that muscles give a much more ready, vigorous, and agreeable response to the will and to the *faradic current* after massage than they do before." Dowse made the following demonstration before his class: A child suffering from infantile paralysis was introduced, the affected limb having a surface temperature of 70° F. The poles of a battery were applied to the limb, and eleven milliampères were required to produce muscular contraction. The limb was then masséed, and the temperature was found to have risen to 95° F. The poles being again applied to the same points, contraction followed the employment of only five milliampères. It is evident, therefore, that massage diminishes the resistance of the tissues to the electrical current, and increases the electrical contractility of the muscles.

Let us now consider for a moment the effects of general massage and movements upon the entire system. It may safely be claimed that by the combined use of these methods we are able—

1. To cause an increased flow of blood to the muscles and other vascular tissues, thus increasing the activity of the circulation, and promoting tissue-metamorphosis and the removal of effete material.

2. To strengthen muscular fibre, and, by setting up molecular vibrations, to induce changes not only in muscle- and nerve-fibres, but retroactively even in the nerve-centres.

3. To promote the absorption of effusions and exudations and to break up adhesions.

4. To increase the oxidizing processes in all the tissues, but especially in the muscles.

5. By what may be termed physiological counter-irritation or derivation to relieve local stasis and congestion of the internal organs at will by compelling the blood to flow into the great muscular reservoir.

6. To act directly upon the sympathetic nervous system, thus stimulating secretory action.

7. To act through reflex nervous influence upon involuntary and unstriped muscular fibre.

8. By symmetrical and normal development of the entire muscular system to restore lost counterpoise between that and the nervous and vegetative systems, and to overcome irregularities in muscular action and distortions depending upon them.

Observations on the effects of general massage on persons in ordinary health have been made by Zabludowski, Gopadze, and Von Mosengeil. Zabludowski's experiments were made upon himself, his servant, and his housekeeper, all adults in early or middle life. All lived under precisely the same conditions, and careful examinations of weight, muscular strength, temperature, pulse, respiration, and urine for eight days previous to, during, and eight days following the ten days of daily massage. The result was an increase of muscular strength in all; decrease of corpulence in one and increase of weight in one; increased excretion of urates and phosphates in the cases in which weight was reduced; decrease of urates and increase of sulphates in the case in which the weight was increased. In all a general elevation of the functions of life, increased appetite, and more refreshing sleep were noted.

Gopadze selected four medical students as his subjects. They were treated by *centripetal stroking,* beginning at the extremities, followed by *kneading, friction,* and *percussion,* the treatment terminating with a repetition of the stroking. In all the cases the appetite was increased, not only at the time, but for a week or two following the week of massage. The amount of nitrogenous transformation was augmented. During the week two gained and two lost in weight, but during the week following all gained. The temperature in the axilla fell slightly. The respirations increased in frequency and depth. The pulse was slightly accelerated by light stroking, and somewhat retarded by kneading, but with either it became fuller and remained so for an hour.

Therapeutic Applications.

Having thus become acquainted, somewhat cursorily, with the mode of administering movements and massage, and their physiological effects upon the system, we are prepared to consider the classes of diseases in which their employment is likely to prove efficacious, and the manner in which they may be prescribed to the best effect in certain affections and conditions. It may be said, in a general way, that whenever we desire to modify profoundly the processes of nutrition, to remove effete material from the system, to stimulate assimilation and invigorate digestion, to soothe nervous irritability and relieve nerve-pain, to arouse dormant nerve-force, to remove morbid deposits from, and from the neighborhood of, inflamed joints, and thus restore their normal mobility, to equalize the circulation, drawing the blood from the hot head, congested abdominal viscera, or laboring heart, and accelerat-

ing its passage through the cold extremities,—we may find a safe resource in this system.

As a rule, it is contraindicated in acute febrile affections, except in the form of light centrifugal stroking for the purpose of quieting nervous excitement and promoting sleep. The one exception to this rule is the case of membranous croup, in which it is often an aid to the dislodgment of the false membrane. Kneading, friction, and light percussion are the appropriate methods to be resorted to for this purpose.

Let us now take up the separate systems of the human organism, and consider the applicability of massage and movements to the relief of the diseases and derangements of each.

Diseases and Disorders of the Digestive System.—It is probably in its effects upon derangements of digestion, taking the term in its widest sense, that the medical profession has been inclined to place the most faith in the employment of massage and movements, and not without reason. Dyspepsia in its various manifestations, constipation, diarrhœa, intestinal obstructions, including hernia and intussusception, chronic catarrhs of the stomach and bowels, engorgement of the liver, catarrh of the gall-duct, and gall-stones, are all treated mechanically with excellent results.

DYSPEPSIA.—It is principally in the atonic form of gastric indigestion that this method is successful. This is characterized by deficient peristaltic action of the muscular coat of the stomach and bowels, deficient secretion, flatulent distension, a sense of præcordial oppression, palpitation, and cold extremities. It is important in treating affections of the stomach to allow a considerable period of time—at least two hours—to elapse after taking a meal before beginning massage. The position of the patient during massage should be such as to relax the abdominal muscles to the fullest extent. Sitting with the body somewhat inclined forward, and with the elbows resting on the knees, answers well. Abdominal kneading, vibrations, and mild percussion over the organ are the forms of massage to be employed. The movements must be such as bring into play the abdominal muscles, both straight and oblique, increase the respiratory movement and play of the diaphragm, and stimulate the general circulation.

Reibmayr considers that massage is indicated—either alone or as a supplement to the other modes of treatment—in acute and chronic gastric and intestinal catarrhs, dyspepsia, cardialgia, dilatation of the stomach, intestinal obstruction (ileus), tympanitis not dependent upon inflammation of the peritoneum, ascites, and, finally, all the sequelæ of peritoneal inflammation, such as firm peritoneal or extraperitoneal exudations, swellings, and adhesions; always provided that the inflammatory process is completely at an end. All inflammatory

affections of the peritoneum, malignant tumors, and deep ulcerations of the stomach or intestines contraindicate its employment.

Rubens-Hirschberg speaks well of the beneficial effects of massage in many affections of the stomach. In cases of dilatation, for example, in which the muscular tissue is weak and the food is too long retained, it excites this viscus to contraction, and by determining a flow of blood to the parts improves its nutrition. It increases the secretion of the gastric juice, and is especially useful in atonic dyspepsia. It relieves the symptoms of pain, weight, and discomfort from which dyspeptics frequently suffer, and is one of the best remedies for flatulence, quickly expelling the accumulated flatus. By stimulating the nerves of the stomach it is beneficial in many gastric affections of nervous origin. The best results are obtained in cases of chronic dyspepsia due to catarrh of the stomach associated with dilatation. In the dyspepsia of anæmic or chlorotic girls it yields equally good results. The increased supply of blood to the walls of the stomach is inimical to the formation of gastric ulcer, but when once an ulcer has formed the employment of massage is distinctly contraindicated, as it might give rise to perforation. It should never be resorted to when malignant disease is suspected.

Murrell observes that in dyspepsia and other functional disorders of the digestive apparatus massage is most useful. Applied to the abdomen, it is a powerful stimulant to both the gastric and biliary secretions. Gopadze and Shpoliansky have shown that under the influence of massage food is retained in the stomach a much shorter time than usual, and in cases of slow and difficult digestion kneading, alternating with intermittent pressure with the warm hands, has been found by M. Dally to be most valuable.

The following prescription will simply serve to indicate the character of the movements to be employed. It is of course susceptible of many modifications :

1. Opposite standing, longitudinal spine chopping.
2. Relaxed inclined standing, abdomen kneading.
3. High opposite standing, leg backward pulling.
4. Hook-half lying, stomach vibration.
5. Sitting, alternate trunk twisting.
6. See No. 4.
7. Half stretch high-side-sitting, sideways flexion.
8. Half lying, leg extension.
9. Stretch sitting, arm-flexion with knee-spine stroking.

In the large majority of cases dyspepsia is associated with constipation.

Constipation.—Murrell does not exaggerate when he says : "For constipation it is certainly one of the most powerful therapeutic agents

at our command. Kneading of the abdomen is the best method, care being taken to make the requisite manipulation in the direction of the ascending, transverse, and descending colons. It should be associated with different varieties of percussion—the flat open hand, the hand partly closed so as to form an air-cushion, and the margins of the hands, being employed according to circumstances. Vibratory movements are in addition resorted to in obstinate cases. Mechanical vibration is especially serviceable." Years ago Piorry advocated a mode of treatment for constipation which is not essentially different from that now described. Auerbech says: "Disorders of the digestive apparatus, and especially constipation, constitute one of the most marked indications for the employment of massage. When there are no complications, but the symptoms are due to disordered secretion, one can always effect a cure in one or two months, or, at the outside, three or four. Massage answers admirably for women who suffer from this condition, especially when there is a lax condition of the walls of the abdomen resulting from frequent pregnancies. It is of the greatest service, too, in constipation associated with obesity, and in that form of constipation which frequently results from taking too little exercise."

Reibmayr believes that he is not saying too much when he asserts that "*for habitual constipation, especially in persons of sedentary habits, abdominal massage, combined with pelvic gymnastics, constitutes the most desirable, sure, and efficient remedy that we possess.*"

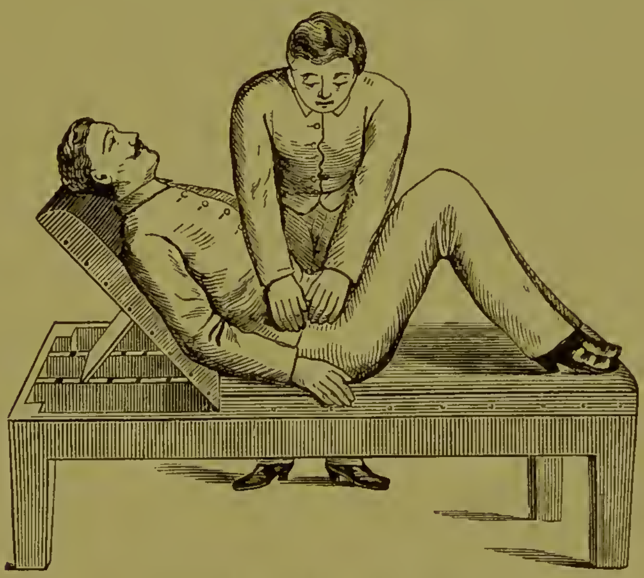
Recurring to its physiological effects, we should bring it into use in all those affections in which we desire to regulate the peristaltic movements of the stomach and bowels; to exert a favorable influence on the circulation of the blood and of the lymph, so closely dependent upon those movements, and hence to act secondarily on the secretion and excretion of the digestive juices; to expedite the absorption of exudations; and, finally, to dislodge obstructing fæcal masses in the intestinal tube by direct mechanical action.

In this connection Graham observes: "Atony of the muscular coat of the stomach or intestines, with deficient peristaltic action and consequent disturbances of digestion, accompanied with distension from flatulence or solid contents, is usually benefited to a marked degree by appropriate massage after ordinary exercise and other measures fail. That benefit is more likely to follow here from repeated treatments than as an immediate effect would show that the nerve-centres that preside over these functions have undergone a nutritive change which it has taken time to produce, and hence that the improvement would most likely be lasting. Moreover, when the alimentary canal is distended by gas or overburdened by solid contents the nutrition of its walls must suffer from languid circulation, as any muscular organ

would that was continually stretched and inactive. Massage improves the circulation, and pushes along the contents of accessible portions of the stomach and intestines at the same time, besides directly stimulating the muscular fibres to contraction and reacting on the nerve-centres, thus improving function and organization in various ways."

Virchow refers portal congestion to two prime causes: First, to disturbed innervation of the muscular coat of the arteries and veins, leading to loss of tone, the elastic fibres gaining the preponderance. In consequence, the vessels become dilated and relaxed, the blood flowing sluggishly, just as any stream flows more slowly when turned into a broader bed. Secondly, to venous congestion from diminished cardiac power. All kinds of digestive difficulties naturally develop from these

FIG. 118.



Hook-half lying, colon kneading.

circulatory disturbances. The distended portal venous radicles lose, to a great extent, their absorptive capabilities, and the lymphatics being unable to meet the increased demands made upon them, it follows as a matter of course that the food-mass remains in the stomach and intestines an abnormal length of time. In consequence of this, all sorts of fermentative changes go on in the mass, the products of which, being absorbed in the blood, give rise to a general disturbance of nutrition. The thus altered contents of the alimentary canal by irritation of the mucous membrane cause reflexly all kinds of nervous symptoms, such as nausea and vomiting, colic and cramps, and, as the result of chemical changes, eructations, heartburn, and sour and bitter tastes. The coexisting constipation too, by barring the way for the escape of those gases which are always developed during digestion, gives rise to flatulency.

These are just the conditions, it will be remembered, which mas-

sage is calculated to relieve, stimulating innervation, promoting absorption, exciting the contractility of the venous radicles, and hastening the passage of the digested food-mass through the intestinal tube.

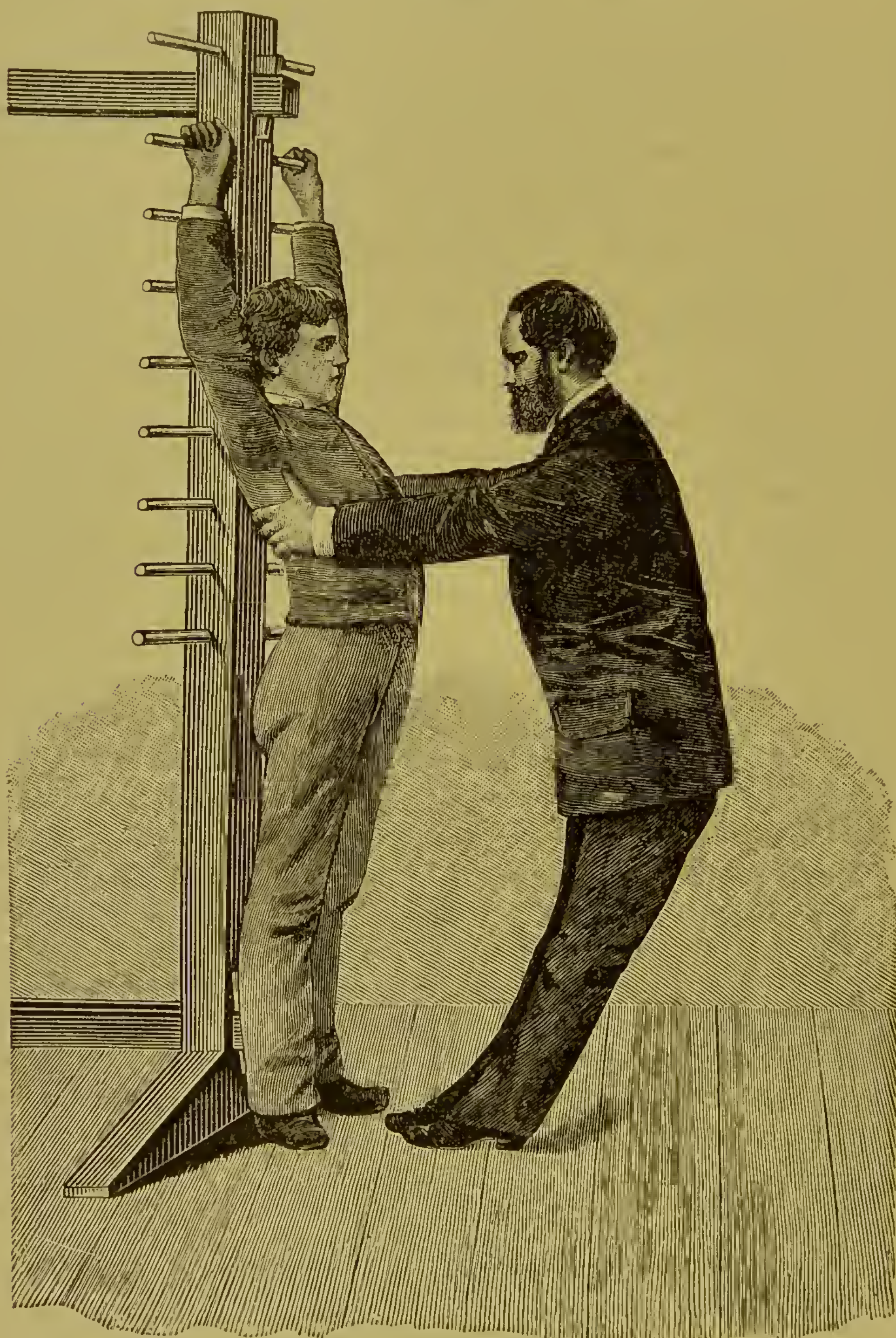
Bueler, as quoted by Murrell, considers that "the physiological effects of massage in the treatment of constipation may be classified as follows: (1) The mechanical action, which is the most important of all, and is not limited to the gastro-intestinal contents, but extends also to the large abdominal secretory organs, removing obstructions of their ducts. This is shown by the success of massage in cases of fæcal accumulation, jaundice due to obstruction of the common bile-duct, ileus, invagination, volvulus, etc. These mechanical effects are best produced by kneading, which breaks up impacted fæcal matters, and by stroking, which facilitates the excretion of materials loosened by the former manipulations. (2) The reflex effect of massage is shown by contraction of the involuntary muscular tissue of the intestine which follows stimulation of the abdominal parietes. This effect is best produced by percussion. Many cases of habitual constipation can be cured by manipulations of this kind alone. This is well illustrated by the case of a student who had suffered from constipation for five years, and who was permanently cured after a course of treatment of eight weeks' duration, the percussion being resorted to three times a week. (3) The thermic action is shown by observations already related in detail. This action is allied to the treatment of constipation by the application of hot poultices to the abdomen and to certain hydrotherapeutic measures. (4) The chemical action is more hypothetical. It is suggested that abdominal massage, whilst causing marked hyperæmia of the local integuments, gives rise to an arterial anæmia and venous hyperæmia of the peritoneum, with an accumulation of carbonic acid in the intestinal circulation leading to increased peristalsis. The problem of the practitioner in every individual case of constipation," says this author, "is to find out which of the therapeutic elements of massage is most suitable and promising —whether the procedure must aim only at strengthening the tonicity of the abdominal muscles or must act mechanically or in a reflex or thermic manner." This question being settled, the procedure can be considerably simplified by omitting all unnecessary manipulations. We must strongly condemn the routine practice of massage in all cases without discrimination, and insist on the strictest adaptation of the treatment to each particular case. Manipulations which lead to a rapid cure in one group of cases may be followed by injurious consequences in another. Thus, in case of chronic constipation due mainly, if not entirely, to weakness and flabbiness of the abdominal walls, as in women who have borne many children or in men advanced in years with big pendulous bellies, such manipulations as forcible separation of the abdominal recti by the insertion of the tips of the fingers

between the edges of the muscles along the linea alba are indicated. The muscles contract forcibly, and this action may be intensified and prolonged by transverse stroking in an outward direction from the medial line. Concurrently with this, the diaphragm should be strengthened by deep inspirations performed forcibly and regularly, as in the practice of artificial respiration. On the other hand, in cases of constipation due to atony of the intestine, such as occur in persons of sedentary habits, the treatment must consist of gentle, gradually intensified, and more powerful stroking, followed by moderately strong percussion with the palm of the hand. In constipation due to dyspepsia, complicated perhaps with dilatation of the stomach, the manipulation should consist of stroking, limited to the gastric area. Two cases of this kind treated in this way twice a week were permanently cured in a month. The massage must be similarly localized in cases of fæcal accumulation in the cæcum or sigmoid flexure. In habitual constipation dependent on cerebral or spinal neurasthenia, especially common in hypochondriacal or hysterical subjects, only such procedures as percussion and stroking are indicated. In this connection Mr. Treves says: "With regard to its effect in cases of fæcal accumulation it must act largely as a mechanical agent, influencing the conformation of the stercoral mass and modifying its position. It would appear also to act as a direct stimulant to the intestine, for within a few minutes of the commencement of the manipulation peristaltic movements are excited, which may in time reach such a grade as to cause much colicky pain. It is possible that such an effect may be brought about by the immediate stimulation of Auerbach's plexus, under the control of which the peristaltic rhythm is supposed to lie. The stimulation also of the skin of the abdominal parietes may not be without influence. It is supplied by branches from the last seven of the dorsal nerves, and it is significant that it is from these very nerves that the splanchnics are in great part derived. The part played by the splanchnics in the abdominal nervous system need not be commented upon. Their precise influence upon the bowel has yet to be established, but, as far as movement is concerned, they appear to contain both excitor and inhibitory fibres."

Berne of Paris points out, very justly, that before undertaking the treatment of a case of constipation by massage it is essential to make a careful examination with the view of determining the absence of any contraindication, such as a tumor or chronic inflammation. The hepatic region should also be examined to see whether there are biliary calculi in the gall-bladder, for if there are care will have to be taken not to make too great pressure on the adjacent parts of the transverse colon. Berne's conclusions may be briefly summed up as follows: (1) Abdominal massage is the best method of treating constipa-

tion which has resisted other remedial measures. (2) No single sitting should exceed twenty minutes, and there should be from the first at

Fig. 119.



Span-standing, chest-forward pulling.

least one a day. (3) A natural action usually takes place after about the sixth application, and the beneficial effect continues long after the cessation of the treatment. (4) Pressure should be exerted over the

fundus of the gall-bladder, so as to induce it to contract and assist the progress of the bile toward the intestine. (5) Massage induces a more abundant secretion of the gastric juice and stimulates the contraction of the muscular coat of the large intestine. (6) In addition to stimulating reflex action, massage acts mechanically, and under its influence intestinal changes take place more actively.

Considerable space has been devoted to the treatment of this condition, because, first, we find it associated, either as cause or effect, with almost every other affection we are called upon to treat; secondly, it is in itself one of the most frequent of all disorders; and, thirdly, because abdominal massage is one of the most difficult of the combined procedures of massage, and must be done skilfully and with intelligent discrimination in order to obtain good results.

The following is a specimen prescription for this most common and troublesome of all derangements of the system among civilized peoples:

1. Opposite-standing, curtseying, abdomen and loin pressure.
2. Sitt-lying, raising, knee support.
3. Relaxed inclined sitting, side abdomen vibration.
4. High-ride sitting, trunk rotation, abdomen and loin pressure.
5. Span-half hook standing, knee downward pressure.
6. Hook-half lying, suprapubic pressure.
7. Span-standing, colon stroking.
8. Span-standing, high-twisting.
9. Span-standing, chest-forward pulling.

DIARRHŒA.—The indications for the employment of remedial movements in diarrhœa are not so apparent as in constipation, and yet on reflection they will be found to exist. In the first place, diarrhœa, as is well known by all practitioners, often indicates that somewhere in the intestinal tube there is retained a mass of irritating material, which by its presence provokes a profuse secretion of watery mucus, and which at the same time only allows the more fluid portion of the intestinal contents to slip by it. Such a mass being found by careful manipulation, it is only necessary to get rid of it to accomplish the principal part of the cure of the diarrhœa. Secondly, there is usually present in chronic diarrhœa a relaxed condition of the tissues generally, and especially of those of the intestine. A general development of the tone and vigor of the voluntary muscles is always followed by increased tone in the non-striated muscular fibres wherever found. Derivation of the fluids of the body to the extremities will naturally diminish the intestinal flux and promote general nutrition and a purer blood, and therefore less irritating secretions.

All the movements in the earlier part of the treatment must be passive. Kneading of the abdomen, unless for the removal of an impaction, must be carefully avoided. Vibrations and gentle percussions

will be of great service. Instead of insisting on a position which will relax the abdominal walls, it is better to have the limbs extended and the muscles slightly tense. In this way we are able to stimulate without producing irritation.

Asiatic Cholera.—Whether cholera should be considered a disease of the digestive or of the nervous tract is an open question. Certain it is that some of its most striking and terrible manifestations are in the domain of the latter. One of the most potent means of overcoming the frightful cramps which accompany it is general massage. By means of persistent stroking and kneading the spasms are soothed, the capillary stasis is overcome, the circulation of the blood is restored, and collapse is succeeded by healthy reaction. This has been a successful method of treatment in India for centuries.

Functional Derangement of the Liver with or without congestion or engorgement is almost invariably an accompaniment of prolonged indigestion and chronic constipation or diarrhœa. Hence, when we are called upon to treat this condition, it is usually masked by these affections and has existed for a long time unsuspected by the patient. The liver and spleen are accessible to both direct and indirect treatment. Direct massage can be made available only when these organs are enlarged, and therefore but partly covered by the ribs. Simple hypertrophies of the spleen and liver, not dependent upon new growths, may be designated as favorable objects. The liver may also be reached indirectly. The circulatory relations of this organ are, as is well known, intimately connected with the blood-pressure in the intestinal vessels, and especially in the portal system. But this pressure, again, is principally influenced, whether favorably or unfavorably, by the tension of the contractile elements of the intestinal walls, the muscular coat, and still further by their peristaltic action. By stimulating the peristaltic movements, therefore, we can influence the intestinal circulation, and through it the degree of blood-pressure in the liver. The latter being the efficient agent in the secretion and excretion of the bile, this function thus comes under the domain of the indirect powers of massage. From what has been said, the special diseases in which its employment is indicated will readily occur to the reader—viz. hepatic congestion and jaundice. In *chronic hepatic congestions,* especially with considerable enlargement, Durand Fardel has found massage well suited to give relief. Together with local massage (stroking) over the region of the liver, general massage of the abdomen should be made use of at least once daily for fifteen minutes.

The liver is so situated that it is quite amenable to massage. It can be reached by percussion and vibration through the chest-walls, the right hand being thrown above the head to render the latter tense. By inclining the trunk forward and relaxing the abdominal muscles the

lower border of the liver and part of its under surface can be reached. In this way not only can the sluggish and distended gall-bladder be emptied and its fluid contents be sent out to do their appropriate work in intestinal digestion and disinfection, but by cautious manipulation gall-stones, even when long impacted, can be dislodged. When such an obstruction exists, the distended bladder can generally be felt without much difficulty, and by steady pressure upon its fundus, with gentle stroking toward its mouth, it may be made to expel the obstructing substance. Several successful cases of this kind are recorded by Dr. George Harley. These cases are so instructive as to be worthy of attention. They are detailed by Dr. William Murrell, in his *Masso-Therapeutics*. In one instance Dr. Harley succeeded in safely extruding into the intestines of a lady, aged fifty-five, a gall-stone the size of a small hazel-nut which had been for many years impacted in her bile-duct and had brought her to the verge of dissolution. In another case, as the result of fifteen minutes' manipulation, he expelled two facetted sharp, angular gall-stones the size of beans, affording such immediate relief that the patient experienced no difficulty in searching for them himself in the motion which speedily followed.

The third case is so remarkable that it is given in full as Harley related it. The patient was a lady sixty years old, who had suffered for twenty years with dyspepsia and flatulent colic. "When first called to her bedside," he says, "I diagnosed a gall-stone firmly impacted in the common bile-duct; and as I proposed to subject her gall-bladder to digital manipulation in order to force the impacted concretion out of the duct, it was arranged that as soon as possible she should proceed to London. The distance was only fifty miles, and yet such was the fatiguing effect of the railway journey upon her that when she arrived in town she was in a state of collapse, from which she did not sufficiently recover to admit of my beginning the treatment for three days, and it was not until a week more had passed that the impacted stone was successfully dislodged from the duct, and only after four days more was it discovered in the stool. The stone, which was of the size of a small field bean, proved on analysis to consist almost entirely of cholesterin, and, although it was not facetted, there was no doubt in my mind that it was one of many, for I could feel the gall-bladder quite distinctly as a hard ovoid body, the size of a man's fist, about three inches to the left of the umbilicus and immediately below the enlarged liver. A daily course of digital manipulation of the gall-bladder was accordingly recommended and had recourse to, with the result that over seventy gall-stones were found in the stools during the subsequent seven months. At the end of that time, the gall-bladder appearing to have been completely emptied of all its calculi, the patient left for the country; and it is no exaggeration to say that, soon after, all

the dyspeptic symptoms which she had suffered from for years previously disappeared. In this case rarely more than one gall-stone was voided at a time, though occasionally, after a biggish one had for six or seven hours blocked up the duct and caused jaundice before coming away, two or three smaller ones rapidly followed its extrusion, without producing any other symptoms than a trifling epigastric discomfort. It must be added that the calculi differed very much both as regards their naked-eye appearances and chemical constitution, some being almost white, others brown, and not a few blackish-green—differences no doubt arising from the stones having been formed at various times and under different conditions during the twenty or more years the patient had suffered from the biliary derangements which had not only been originally diagnosed, but always previously treated, as severe indigestions."

Gopadze speaks well of the influence of massage in catarrh of the common bile-duct. The symptoms observed in fourteen cases were jaundice, vomiting, loss of appetite, and constipation alternating with diarrhœa. Massage in the region of the liver effected a cure, on the average, on the eighth day.

INTESTINAL OBSTRUCTIONS may be due simply to obstinate constipation, the stercoral mass becoming so large and firm, and so closely embraced by the irritated bowel, that nothing can pass beyond it, or the obstruction may be due to intussusception, volvulus, or hernia. Whether due to impacted fæces or to other causes, it produces vomiting, sometimes stercoraceous in character, local pain, and great prostration. Careful manipulation reveals the hardened fæcal tumor, oftener in the neighborhood of the ileo-cæcal valve than at any other point, sometimes at the sigmoid flexure or in the rectum. In manipulating such a mass it will be useless to attempt to force it on by a *vis a tergo*—perhaps dangerous. Strokings, at first very gentle, then gradually increasing in force, should be begun some distance beyond it, toward the rectal end of the gut. These should gradually approach it, thus as it were inviting it onward. By kneading of its rectal end, and gradually of the whole lump, it may be pressed out, elongated, and finally broken up, and carried on by firm strokings in the direction of the axis of the canal. Percussion would here manifestly be out of place. Much gentle persistence and patient labor is the key to success.

INTUSSUSCEPTION.—If in such cases we detect a stercoral mass, it is always well to break it up by persistent careful kneading, as its presence at the point of involution is an interference with the disentanglement of the bowel. Stroking in different directions will then often result in the restoration of the canal to its patent condition.

HERNIA has been treated by massage from time immemorial. The diagnosis of hernia and the description of its various seats

would be foreign to the purpose of this article. Suffice it to say, that massage and posture are appropriate to all forms and locations of hernia. The proper manipulations for the reduction of strangulated hernia are thus described by Agnew: "In the hands of unskilful men the taxis serves to put things very much out of order, and it should be undertaken only under a clear apprehension of the regional anatomy of the hernia and the rationale of the force to be employed. Some proceed, it would seem, under the impression that the work is to be done by force; others act as though the whole manipulation consisted in pushing. Now, it should be clearly understood that neither the one nor the other is proper—that the parts must be handled with great gentleness, and not rudely, otherwise inflammation may be provoked or even rupture of the sac of the intestine may follow. When the force is applied by pushing the mass upward, it will merely crowd the contents of the sac against and around the seat of stricture or force them into some side-pouch. The two dominant thoughts in the use of the taxis are to steady the neck of the sac and to empty the intestine of its contents, for by so doing the disproportion in size between the bowel and the rings is lessened. As soon, therefore, as the patient is rendered insensible and the parts are properly relaxed, the surgeon, if the hernia be an *inguinal* one, places the thumb on one side and the fingers on the opposite side of the external ring, so as to prevent the sac from bulging over the pillars of the latter; with the other hand he grasps the body of the tumor, and, first drawing it downward and outward in the line of the canal, so as to straighten the cavity of the bowel, he begins to compress the hernia with a moderate degree of firmness, graduating the force in such a manner that, with the exception of the fundus, where it should be greatest, the pressure shall be evenly distributed over the tumor. This compression must be maintained continuously for eight or ten minutes, when perhaps a peculiar sensation will be felt and heard (gurgling), caused by the air passing out of the rupture. This is the sure precursor of reduction, and in a few moments more the sudden slip of the entire contents back into the abdomen will be noticed. When the omentum alone is the occupant of the sac, the restoration is effected slowly, one fold after another of the membrane receding until all is replaced.

"In applying taxis to *femoral* hernia, should the tumor have turned upward over Poupart's ligament it must first be dragged down into the groin, after which the thumb and fingers of one hand should be placed on opposite sides of the saphenous opening, while with the other the rupture is compressed and simultaneously pushed backward and slightly upward, in order to direct it into the saphenous opening and through the femoral ring into the body. There is a limit to the use of the taxis. If the reduction is not accomplished in ten minutes, our efforts should

cease and resort should be had at once to the knife. A large or an old hernia will tolerate a longer manipulation than a small or a recent one. In any event, taxis should not be persisted in for more than ten minutes. Not unfrequently the hernia has been subjected to prolonged manipulation before the surgeon is called, and, if there is reason to believe that the taxis has been used properly, it will be better to confine further efforts at replacement within the limits of five or six minutes. When, from handling, the hernia has become exceedingly sensitive or painful, and when there is reason to believe that mortification has begun in the contents of the sac, taxis is not allowable. Mr. Birkett thinks that the presence of hiccough contraindicates the employment of taxis. This is the case when, associated with the sudden subsidence of pain, there are present a feeble, frequent pulse and cold sweats, with extreme prostration, as these are the signals of commencing mortification; but hiccough is sometimes present when there is no evidence whatever that the vitality of the hernial contents is destroyed, and under such circumstances manual attempts at reduction should not be withheld.

"Surgeons sometimes place the patient in unusual postures as adjuvants to the taxis; such, for example, as laying the person on an inclined plane, with the head and the shoulders low and the limbs bent over on the abdomen, or suspending the individual by the heels, or simply raising the pelvis upon a pillow, the thorax and lower limbs being at the same time flexed upon the body. Another device consists in grasping the relaxed parietes of the abdomen and pulling them as far forward as possible. A folded sheet has been passed around the lower part of the body and the viscera forcibly drawn upward.

"Inguinal hernia is much more frequently restored by taxis than is femoral; and it should not be forgotten that, as a rule, the last form of hernia is much less tolerant of manipulation than the first.

"In attempting the reduction of *strangulated femoral* hernia, the patient should be placed under an anæsthetic, the head and shoulders well raised, the leg on the affected side flexed upon the thigh, and the latter bent upon the pelvis, with the knee turned inward toward the opposite side. This position ensures the most complete relaxation of the structures about the saphenous opening. The surgeon now draws the tumor down upon the thigh, should it have turned up over Poupart's ligament, and then, after using steady, gentle compression to its sides for one or two minutes, pushes it backward into the external femoral opening, and at the same time upward in the direction of the internal femoral ring. The reduction will be favored by placing the thumb and fingers of the other hand on the margin of the saphenous opening in order to prevent the contents of the hernia from overlapping its sides. To secure the full benefit of taxis it is absolutely necessary that the practitioner should understand the anatomical peculiarities of

the femoral region. The three movements demanded for reduction by the relation of the hernia to the region through which it descends are the following: downward, backward, and upward. If these have been properly tested for six or eight minutes without success, an immediate resort to the knife will be necessary.

"In order to reduce a *strangulated umbilical hernia* the patient should be placed under the influence of an anæsthetic, the head and the shoulders raised, and the limbs drawn up so as to relax the abdominal parietes. The surgeon next grasps the tumor with one or both hands, according to its bulk, and after drawing it forward in order to elongate and consequently narrow its contents, he compresses it with a view to displace the flatus, and, lastly, pushes the contents of the rupture upward and backward. If a certain portion of the hernia be more tense and resistant than the rest, the taxis should be addressed to that part, as it is highly probable that the obstruction is dependent upon the presence of a loop of intestine in addition to that ordinarily within the sac."

Obesity, or **Corpulence**, is a condition depending in some unexplained way on defective digestion—probably intestinal—and faulty assimilation. Few morbid conditions, not painful, cause their victims more physical discomfort or mental annoyance. It embarrasses respiration, impedes the circulation, circumscribes muscular activity, and often renders locomotion difficult, if not impossible. A nitrogenous diet, with avoidance, as far as possible, of hydrocarbons, is of course to be recommended. Combined with this, massage and movements are of the greatest possible service. Our first object must be to stimulate the great emunctories, and thus provide an outlet for the fatty detritus which we propose to send to them later. First among these are the liver and intestinal epithelium—the former not so much for the amount of excrementitious matter which it throws out as for the value of its secretion as a scavenger in sweeping away the débris of epithelial desquamation, uncovering the outlets of the excretory ducts, and stimulating the renewal of their cells. Vigorous abdominal massage, with special reference to the liver, is therefore the first indication. To begin with movements of the extremities would only result in forcing a turbulent and muddy stream onward to a reservoir whose outlets are clogged and obstructed, thus damming up the current, damaging the sluice-gates, and leaving morbid deposits in the abdominal glands and viscera. By stimulating the abdominal nerve-centres by means of the reflex and electrical influences of rapid superficial stroking, and following this up with deep strong kneading, the secretions are first augmented, and the peristaltic action is then stimulated to carry them off. Strong percussion of the liver with the full palm of the hand, already described as *liver-clapping*, is then to be

employed, followed immediately by pressure on the fundus of the gall-bladder, if possible, for the purpose of increasing the secretory action of that organ and of mechanically hurrying the bile through the gall-ducts and out into the intestinal canal. Next, in order to call the reinforcing power of the spinal cord to the aid of the splanchnic and sympathetic nerves, rapid percussion of the spine must be made use of, the blows being delivered with the finger-tips, beginning at the base of the brain and going down to the sacrum, especial attention being given to the lower half of the dorsal region. This is to be followed by the usual back-stroking, in order to soothe any undue nervous irritation that may have been caused. Vigorous duplicated flexions and extensions of the thighs, with the view of compelling the abdominal muscles to contract strongly, and also by the action of the psoas and iliacus muscles to stimulate the pelvic circulation, will conclude the treatment, which should be administered daily for the first week, and after that twice a day.

Diseases of the Circulatory System.—It is certainly contrary to all our preconceived notions that exercise *per se* should be beneficial in *diseases of the heart.* Rest would seem to be the first indication. In point of fact, the movement cure has won some of its greatest triumphs in this class of cases. To understand this we must bear in mind the strong compensatory efforts which nature makes in all valvular affections of this organ, adapting the capacity of its cavities and the thickness of its walls to the demands made upon it by altered mechanical conditions. No one pretends that the organic changes which have taken place in the valves themselves can be remedied. To what extent a pure blood is capable of dissolving growths of low vitality upon their surfaces we do not know. But we do know, as already stated, that coincident with increased tone of the voluntary muscular system, taken as a whole, we have also increased tone of the involuntary muscle-fibre wherever found. We also know that stasis in the venous capillaries, and consequent defective circulation and imperfect nutrition, are invariable accompaniments of cardiac affections. This capillary congestion is relieved by massage and by such a carefully regulated system of movements as shall develop the general muscular system without draining the nerve-force or unduly exciting the respiration.

Lauder Brunton says: "We all know how active exercise increases the appetite. Tissue-change goes on more rapidly in the organs, waste is more abundantly excreted, and more food is eagerly sought for. But there are many feeble, flabby persons who cannot take exercise, or, if they can, will not. Moreover, there are others who are quite willing to exercise the voluntary muscles of the limbs, but cannot exercise the involuntary muscles of their internal organs. Now, treatment by massage helps both of these. It increases the nutrition, both

of the voluntary muscles and of the internal organs, and under its use patients apparently incurable completely recover."

Graham aptly describes the assistance given to a laboring heart by massage in the following language: "Exercise accelerates the action of the heart and diminishes blood-pressure, which means an increase in the rapidity of the current and in the quantity of the flow through the relaxed, distended, or stretched blood-vessels. Massage also diminishes blood-pressure, but without increasing the activity of the heart. On the contrary, the heart's action is generally lessened in force and frequency. And, on reflection, this is what might be expected, for gravity and the friction of the blood against the walls of the vessels are natural obstacles to the circulation, and these, working backward to the heart, have to be overcome at each systole of the left ventricle. These hindrances are by massage, both directly and through the medium of the vaso-motor nerves, in great part removed. The contracting hands of the manipulator are, as it were, two more propelling hearts at the peripheral ends of the circulation, co-operating with the one at the centre; and the analogy will not suffer if we bear in mind that the size of one's heart is about as large as the shut hand, and the number of intermittent squeezes of massage that act most favorably on vessels, muscles, and nerves is about seventy-two per minute, which is about the ordinary pulse-rate."

DROPSY.—So far as their treatment by mechano-therapeutics is concerned, all dropsies, whether œdematous, ascitic, or articular, may be classed together. The experiments which have been detailed in the introductory portion of this article are so conclusive as to the possibility of inducing the absorption of effused fluids by manipulations that it follows, as a matter of necessity, that massage will prove an efficient agent for this purpose in pathological conditions. Two objects must be had in view: First, the removal of the fluid from its abnormal position in the tissues or cavities; and, secondly, its removal from the system, for if we simply procure its reabsorption into the circulation, the only effect will be to distend the vessels and render the blood hydræmic.

In ascites our principal attention will of course be directed to the abdomen. We should endeavor to stimulate the absorbents of that cavity to take up the fluids, and the organs to throw them off. Increased tone of the capillaries will diminish the serous exudation from their walls. Massage of the abdomen and liver and *percussion* and strong stroking over the kidneys are indicated. The results in ascites, however, are not as encouraging as in œdematous swelling of the extremities. Except in the last stages of renal and cardiac disease great relief can usually be obtained, and sometimes complete and permanent removal of the effusion. In this condition

we must use strong upward stroking, beginning at the distal end of the limb and working gradually upward, followed by kneading of the distended tissues, and terminating with abdominal massage and treatment of the kidneys as above suggested.

Schreiber remarks that "œdema of the lower extremities, caused by abdominal growths, can nearly always be greatly relieved, if not entirely removed, by the persistent manipulation (kneading and rubbing centripetally) performed once or twice a day for some time.

"The manipulation, which is very easily learned, should be performed with the patient lying or seated opposite the operator, with his limbs, previously oiled, raised upon a support. At first the rubbing should be carried on quite gently; later, the force can be gradually increased. It is well to begin at the toes, rubbing upward over the ankle and up the leg, either with one hand alone or with both hands placed side by side clasping the limb; or, the hand being half clenched, the inner side of the first and second joints of the first finger may be used. The rubbing and pressing should be maintained equably and forcibly for from five to fifteen minutes.

"In manipulating œdematous abdominal walls the motions should be made from above and outward, in a direction downward and inward toward the inguinal region, for the lymphatics of the anterior and lateral portions of the skin of the abdomen empty into the plexus of lymph-nodes lying within the pelvis and upon the internal iliac muscle. This plexus empties its contents into the superior lumbar nodes, and these again into the thoracic duct.

"Every year I see œdemas arising from the pressure of uterine fibroids greatly benefited by massage. They are all so alike that any detailed description of each is unnecessary."

Reibmayr records his experience that "in superficial œdema, either as a symptom of a general disease or the result of local obstructions to the circulation of the blood (congestive œdema), especially when occurring in the lower extremities, this treatment is peculiarly grateful, usually causing the accumulation to disappear, at least temporarily. Even in severe general affections a diminution may be effected, greatly to the satisfaction and relief of the sufferer. The secretion of urine increases correspondingly with the subsidence of the œdema. We can accomplish no more with diuretics, and neither so surely nor so innocently. If the œdema is the result of thrombosis of the veins of the lower extremities, massage must be employed with caution and the points of obstruction must by all means be avoided.

"Gussenbauer contributes a very interesting case of chronic œdema of the right upper extremity, which had resulted originally from an extensive adhesion among the sheaths of the tendons of the muscles of the forearm, and had harassed the patient for thirty years. He was

relieved of this troublesome affection by means of massage and forcible movements in the short space of three weeks."

"An increase in the quantity of urinary secretion under the influence of massage," says Murrell, "was noticed in a number of cases treated experimentally by Dr. Rubens-Hirschberg. It began during the first twenty-four hours, and increased steadily during the whole of the treatment, subsiding not at once, but gradually on its suspension. In the majority of cases it was unnoticed by the patient, but in one instance the patient complained that, contrary to his custom, he was disturbed at night and had to rise several times and pass water. In most cases the increase was gradual. In one case the patient, who habitually passed from 1500 to 1800 cc. in the twenty-four hours, voided under the influence of massage 2200, 2400, 2500, and 3000 cc. on successive days. On the termination of the treatment the diuresis was not arrested suddenly, but passed off little by little. The regularity with which this was observed in a number of cases points to the conclusion that masso-therapeutics is an agent of not inconsiderable value in increasing the urinary flow. Rubens-Hirschberg considers that it is a vaso-motor action, and that it is due to increased blood-pressure."

Dropsy of the joints and tendons will be more properly considered under the head of "Diseases of the Locomotor Apparatus."

ANÆMIA, HYDRÆMIA, LEUCOCYTHÆMIA, CHLOROSIS, are all closely-allied perversions of the circulatory fluid dependent on defective assimilation. The applicability of massage and movements to these conditions is at once apparent. As they are, one or more of them, almost invariably associated with the condition which it is now fashionable to call neurasthenia, their further discussion will be continued under the head of "Diseases of the Nervous System."

Diseases of the Nervous System.—These conditions, for our purpose, may be broadly divided into *Painful Nervous Affections* and *Paralytic Nervous Affections*. Under the former head we of course class all the *neuralgias*, of whatever type or location. We limit the term to those conditions of chronic or constantly recurring pain which can be directly located in a nerve-trunk or a nerve-ganglion. Myalgia, commonly called muscular rheumatism, is probably simply a neuralgia of the terminal nerve-loops in muscles, but it is not usually classed among the neuralgias.

It may be said, with Reibmayr, as a general statement, that "massage is more fruitful of good results in the treatment of affections of the peripheral than of the deep-seated nerves. To these belong, above all, the neuralgias, which, distributed as they are superficially over the entire surface of the body, afford a most inviting field for massage. Such of them as are dependent upon either incurable lesions of the nerve-centres or the pressure or traction of tumors must of course be

excepted. It is in sciatica, of all the neuralgias, that massage has won its greatest reputation. Truly astonishing results have here been obtained, even when the affection has been of many years' standing and after every other conceivable means of relief has proved unsuccessful.

Neuralgia, as is well recognized, is usually a disease of debility. If, therefore, by means of general massage we can succeed in improving the tone of the whole system and increasing the vigor of the entire body, we shall in a large proportion of cases obtain a cure, even independently of local treatment.

In sciaticas of a rheumatic character induced by cold, the task, as a rule, is an extremely easy one. Strong stroking, alternated with percussion, along the course of the affected nerve, is usually all that is needed to cure the disease in a comparatively short time. Frequently, however, pathological alterations of the nerves or of their sheaths, or chronic inflammations, exudations, and so on in their immediate neighborhood, are the cause of the affection. Since such pathological changes may occur anywhere along the entire course of the nerve, it is a matter of the first importance to determine those positions in which alone local massage could induce absorption of the products of inflammation, and thus remove the suffering. It is a well-known fact that an exudation within the pelvis may be the cause of sciatica. If this proves to be within reach of the touch, pelvic massage will cure it. Such a case is contributed by Winiwarter. The sciatica was in this instance dependent upon a diffuse nodular tumor in the region of the left kidney, an exudation in the peri-nephral areolar tissue. The man had been bedridden for a number of years. After the employment of massage for two months he was completely cured and the tumor had vanished. When the sciatica is caused by tumors which are not susceptible of absorption, or by an inflammatory process so situated that it cannot be reached—as, for instance, deep in the lesser pelvis—massage must prove useless.

"In neuralgias resulting from anæmia, hysteria, and malaria," says Schreiber, "mechano-therapy can exert only favorable influences, for the passive and active movements employed increase the oxidizing powers of the blood, and consequently improve the nutrition of the brain and spinal cord and of the organism generally." This writer devotes more than one-third of the therapeutic portion of his treatise to the details of his treatment of these affections. He advises that in extreme cases of long continuance passive movements be first employed, then active movements, and finally massage. In this way the sensitiveness of the nerve-trunks is gradually diminished, and direct pressure upon them is better tolerated. Taking a supposed case of sciatica, in which it is almost impossible for the patient to lift the foot from the

floor when standing, he sketches the progressive treatment for a period of thirty-two days, day by day. This is very briefly as follows:

1st Day.—Thigh flexion, in the standing position, entirely or nearly passive; it is encouraging the patient to make the effort, and so educates his will, which is usually nearly inert. This movement, which is designed to put the glutei muscles on the stretch, is to be repeated ten times. It is well to have some object, as a bar, the height of which can be graduated, to which the foot should be elevated, the height being increased from day to day. It may be said here that in this as in every effort to restore lost power of movement, even when the result of paralyzing nerve-lesions or cerebral paralyses, it is of great importance to treat the mind as well as the muscles and nerves. Much may be accomplished by encouraging the patient to make the attempt to move a part, and at the same time, without his knowledge, aiding him in the effort. The will is thus coaxed back into its forgotten channels.

The patient then lies on the back on a firm couch or bench, and the attendant flexes the thigh upon the pelvis. This should be done slowly and cautiously, in order not to discourage the patient at the outset by giving him excessive pain. The angle of forced flexion should not exceed forty-five degrees, and the limb should be maintained in that position but for a moment. After a short interval of rest this movement should be repeated, and so on for ten times. Let it here be noted that all duplicated movements should be made very slowly, the patient being compelled to fix his attention on them. It is well, especially if they cause pain, to make him keep the count himself, as it stimulates his pride to reach the requisite number. The principle of alternate rest and exercise is also an important one in passive exercise and massage as well as in active movements. It is well for the patient to lie flat upon the back for two or three minutes several times during a séance.

The passive flexions having been concluded and the patient having rested after them, a very gentle kneading, using only the finger-tips, may be given over the muscles of the thigh and the glutei, as high as the crest of the ilium. It must be expected that considerable pain will follow this procedure, and continue for a period varying from half an hour to two or three hours. It will not be strange, either, if the nocturnal pains should be aggravated for a number of nights. It is well to forewarn patients and their friends of this probable result.

2d Day.—The attempt to flex the thigh actively will be repeated, the patient standing, and he will also be instructed to abduct and adduct the thigh. If necessary he may support himself by taking hold of the horizontal bar. These movements should then be performed passively. He should then lie upon the back, and the same movements

be performed passively. The kneading follows, somewhat more vigorously than on the first day.

The procedures thus far described will now form a part of the routine of each day's treatment.

3d Day.—Kneading with the knuckles is added.

4th Day.—The patient is now to stand on the affected leg and raise the other foot, first to the top of the bar, and then over it. Deeper kneading and percussion may be used.

5th Day.—Every few days the bar should be raised one peg. Kneeling on either knee alternately is now to be used. Each day the passive flexion of the thigh is to be made with greater force, the knee being brought nearer the chest. This movement is in reality a *nerve-stretching without the use of the knife*, and much depends upon its conscientious and faithful performance on the part of the operator, and upon the endurance of the necessary resulting pain on the part of the patient.

6th Day.—First kneeling with the knee of the affected side, then with the other knee. Muscle-chopping will to-day be added to the manipulatory processes. Care must be taken not to use too much force at first, as the procedure is a powerful one and may produce ecchymoses. Schreiber treats these as necessary results and of trifling consequence, indeed even perhaps beneficial. But as he himself admits that it is well to avoid subsequent manipulations over such extravasations until they have been absorbed, it is evident that they interfere with the treatment to that extent. The effect upon the patient's mind, and especially upon that of her friends in the case of a delicate woman, in whom such appearances are most apt to occur, cannot but be painful.

In performing this manipulation the thigh should be slightly abducted and the knee flexed. To reach the inner side of the thigh the physician should stand on the affected side and begin at the knee. The buttocks and the anterior and posterior aspects of the limb may be reached from either side. Bony prominences must be dealt with very gently. This should be the last severe manipulation of the day, but may be followed by a gentle stroking to allay nervous irritation.

7th Day.—The rotators may now be brought into play, both passively and actively. Standing erect, with the heels close together, the patient should be instructed to turn his toes out. The heels are then to be separated, and the toes must be turned in. In both of these movements the knees must be kept straight.

Passive external rotation, usually an extremely painful movement, is conveniently performed by placing the patient in the sitting posture, with the ankle of the affected leg resting across the opposite knee. The operator then makes pressure directly downward on the knee of the lame leg. This must be done with great caution.

8th Day.—The patient may now be made to take a few steps as in

proper walking—*i. e.* bearing his weight equally alternately on each leg, with the body slightly inclined forward. The physician, taking hold of both of his patient's hands, draws him toward himself, thus compelling him to take a step. Schreiber has adopted an ingenious expedient to compel the patient to lift the foot of the affected side instead of dragging it. He places a series of small beams of wood on the floor at even distances, like the ties of a railroad-track, and then, taking the patient's hands, walks backward, drawing the patient after him, and at the same time supporting and steadying him. Curtseying and straddling are now added to the movements.

9th Day.—Sitting and rising from the chair without aid from the arms. Maximum passive abduction of the thighs, the legs hanging on either side of the bench. Very efficacious, but also very painful.

10th Day.—Running over the cross-ties, instead of walking. Rapid passive abduction and adduction of thighs. After forced flexion of the thigh on the chest it is to be extended rapidly and violently.

11th Day.—Rest.

12th Day.—Stepping up on to the horizontal bar, down and over with both feet. Strong kneading of the flexed thigh.

13th to 20th Day.—Repetition of all these movements in various combinations with massage as usual.

21st Day.—Rest.

22d Day.—Flexion of thigh, with knee extended. Crossing the legs, first in the lying, then in the sitting, position. This must be at first passive.

23d Day.—Leaping, first, down from the horizontal bar; secondly, leaping upward and performing abduction and adduction while doing so; thirdly, jumping over the bar. In all these movements the physician holds the patient's hands, supporting and at the same time instructing him how to perform them thoroughly and precisely.

24th to 30th Day.—Repetition and combination of all previous movements and manipulations.

31st Day.—Rest.

32d Day.—The patient should now be able to perform all ordinary movements of walking, sitting, going up and down stairs, etc., with comparative ease. Curtseying and turning while lying are now to be especially practised.

If the case has progressed favorably up to this point, it may be sufficient to have a séance only every other day, and in this way the intervals may be gradually lengthened.

The duration of the treatment will depend, of course, on the previous length of the illness, the extent of the disease, the age, temperament, idiosyncrasies, and general nutrition of the patient, and the perseverance and skill of the operator.

The following is an ordinary prescription for sciatica:

1. Half lying, thigh rotation.
2. Face lying, nerve-pressing and percussion (sciatic nerve).
3. High-ride sitting, trunk rotation.
4. Half lying, knee-upward pulling.
5. Inclined thigh support standing, back extension.
6. High opposite standing, leg inward pressure.
7. See No. 2.
8. Half lying, leg extension.
9. Opposite standing, sacrum percussion.
10. Half lying, foot flexion and extension.
11. Span standing, hip twisting.

(*Explanatory Note.*—High ride sitting is sitting astride on a high stool or narrow bench, in order to fix the pelvis.

Half lying is reclining at an angle of about 45°.

Opposite standing is leaning forward and resting with the elbows or forearms on some object at about the level of the nipple.)

The physician who has followed this detailed account of daily treatment carefully, and appreciated its rationale, will not need to have a similar description of the treatment of neuralgia affecting other main trunks, such as, for instance, cervico-brachial and cervico-occipital neuralgia. Studying the relations of the nerves and muscles of the part, the limitations of motion and impairment of will, he will in the same way direct his efforts toward diminishing nervous sensibility and improving the nutrition of the region by massage and reconstructing the motor capacity by movements.

The value of massage in relieving that form of neuralgia of the head known as *hemicrania* or *migraine* is so great as to entitle this subject to special reference. Congestive headaches also are greatly benefited, especially by massage of the neck.

We have seen that neck-massage, by accelerating the venous current in the numerous superficial veins of this region, may act advantageously upon hyperæmias in the peripheral distribution of the carotid arteries. Its operation is like that of a copious bloodletting, but without the injurious results of the latter. We may therefore bring it into requisition in all *congestions of the brain and its membranes*, whether resulting from an increased tendency of the blood to the vessels of the brain—rush of blood to the head, active hyperæmia; or a retardation of the escape of the blood from the brain—passive congestion. In all such cases we can succeed, in a comparatively brief space of time, in diminishing the blood-pressure within the cavity of the cranium by massage of the neck, and its use is therefore indicated as a preliminary to the employment of the slower derivative agents, such as drastic purgatives and fomentations of the extremities or of the trunk. In

consequence of the rapidity with which it acts it should always be instantly resorted to in sunstroke. The readiness with which it can be applied makes a knowledge of it especially important for the military surgeon, under whose care such accidents most frequently fall.

Gerst urges its employment in concussion of the brain, even when extravasation of blood has taken place within the cavity of the cranium. The observations of Mills, Stoddard, Weiss, and Nonhebel indicate that severe headache and hemicrania often yield to it with celerity.

It is indicated in full-blooded patients, when it can be perceived that the hemicrania is the result of a reflex or vaso-motor dilatation of a branch of the carotid.

In the hemicrania of anæmic, nervous patients it does no good. In these massage must be applied to the scalp, especially over the forehead and temples.

Mills observes: "In some neuralgias and for the neuralgic constitution its usefulness has been established by a number of observers. Both stroking and friction are beneficial in nervous headaches. I have frequently seen the headache of a nervous woman relieved by gently stroking the forehead, while energetic frictions or shampooing of the entire head are sometimes more efficacious with men."

A valuable contribution, entitled the *Treatment of Hemicrania by Massage*, has been made by Norström of Paris. The ground which he takes is that the great majority of the varieties of headache to which this general name has been given are neuralgias of *muscular origin*, accompanied by centres of induration, and often by sensitiveness on pressure along the nucha. The indurations he considers to be the result of chronic inflammatory processes. As he well observes: "To say that this affection is a neurosis, and to act accordingly, is to be satisfied with very little." He claims that the removal of these inflammatory deposits by massage is almost invariably followed by the complete cure of the neuralgia, and that just in proportion as the process of absorption takes place is the degree of improvement. The seat of these muscular lesions, associated with the hemicrania, he has found to be as follows in 32 cases: Superior insertion of the muscles of the posterior cervical region, 14 instances; body and inferior insertion of the same muscles, 19 instances; muscles of the antero-lateral regions of the neck and those of the shoulder, 9 instances; integuments of the cranium, 2 instances; temporal muscles, 3 instances; ganglia of the great sympathetic, 2 instances.

On this subject Vretlind says: "I believe that in many instances hemicrania, considered to be rheumatic or nervous in its character, depends upon or is in close relation with chronic myositis. This myositis does not affect exclusively the muscles of the head; it may

extend to those of the neck, nucha, or even of the shoulders. The connection is usually not suspected, because the muscles are not examined. If I may trust my own experience, the muscles in question are often the seat of nuclei of induration of greater or less firmness. The most important in this connection are the trapezii, especially at their points of insertion into the nucha and the scapula; then the splenius; and finally the scaleni. This condition may exist, and yet the individual not be conscious of pain in the course of the muscle or experience the slightest difficulty in making active movements. On examination, decided tenderness is usually found at the affected points on making somewhat firm pressure, or, if possible, squeezing the muscle between the finger or thumb.

"In order to accomplish this the patient should raise the arm corresponding to the affected side, supporting it upon some object, such as the back of a chair, which is higher than the axilla, and allow it to rest in such a way that the trapezius shall be completely relaxed. In this position its superior border and its acromial portion may be taken between the fingers. Very often there will thus be found, in passing from above downward from the nucha to the scapula, a swollen point of induration which is more sensitive to pressure than the rest of the muscle, and upon such pressure the patient experiences radiating pains which may extend as far as the region about the eye."

Similar observations have been made in Mezger's clinic.

Dr. Walter Johnson says: "If any surgeon or physician, who has not hitherto had his attention directed to this point, will manipulate the flesh of his patients, he will be surprised to find in how many cases he will detect thickenings, hardenings, and swellings in various parts. He will find the necks of nearly all his patients who have suffered for any length of time from head affections swollen and indurated, with most probably enlarged absorbent glands in the neighborhood. The neck and shoulders will frequently be tender to the touch, and the muscular and other fibres will be dry and will crackle perhaps on pressure."

The relation between these foci of induration and the accesses of neuralgic pain Norström regards as that of cause rather than of effect. His treatment is, therefore, massage applied directly to them with a view to procuring their absorption; and this he considers to be only a question of time and perseverance on the part of both operator and patient.

Neurasthenia is the Greek for "nervous prostration." The word was coined by Beard of New York, but whether the addition to our vocabulary has enriched it may well be questioned. This condition of lowered vitality, depressed innervation, enfeebled digestion, impaired assimilation, unbalanced circulation, impoverished blood, superficial

hyperæsthesia, and emotional irritability is usually found among women, and to a greater extent among the women of America than those of any other country.

With its causes we are not concerned in this work. It should probably be located not in the cerebrum nor in the spinal cord, but in the nerve-centres of organic or vegetative life—the great sympathetic, the great solar plexus, the pneumogastric, and their associated ganglia. Let it be borne in mind, however, that nerves, if supplied with good, pure, nourishing food and allowed proper periods of rest, rarely give trouble. They are the most long-suffering of all the bodily organs, and do not cry out or strike work unless starved or grossly imposed upon. Faulty nutrition is generally at the bottom of their grievances and apparent misbehavior. It is not difficult to understand, therefore, that any mode of treatment which will improve the general nutrition of the body and furnish an abundant supply of pure blood will strike at the foundation of all functional nervous perturbations and depressions. This, massage and movements, combined with proper attention to diet and strict enforcement of hygienic precautions in regard to clothing and ventilation, and if necessary seclusion and rest, will accomplish.

The appropriate treatment of this large, increasing, and extremely troublesome class of cases was first sketched by Charles F. Taylor of New York in an article entitled *Carnomania*. But it was not until the publication of S. Weir Mitchell's valuable essay, *Fat and Blood, and How to Make them*, that the attention of the profession was strongly attracted to the importance of massage and movements in the management of nervous exhaustion.

For the purpose of illustrating the mode of their application in this affection let us suppose a somewhat extreme case. The patient is a woman, usually unmarried, of nervous temperament and active brain, aged between twenty and thirty years. She may have enjoyed fairly good health up to the age of puberty, when her manifestations of nervous disturbance became somewhat more marked. Owing to excessive brain-work, as in preparing for graduation at school, or, still worse, "college," or unusual and protracted physical effort or long-continued anxiety, such as accompanies nursing a near relative through a long illness, she has had a "breakdown" and probably a run of nervous fever. Since this attack she has been practically an invalid, sometimes better and sometimes worse, but on the whole quite unfit for the discharge of the ordinary duties of life. She has had an almost constant backache and frequent attacks of gastralgia. Vomiting has not been uncommon. Locomotion has been painful, and has consequently been given up, until she has become bedridden. She has experienced temporary relief from blisters, issues, and possibly a seton over the spine.

Menstruation may or not have been painful, but all her symptoms have been aggravated at that time. It is very probable that she may be suffering from amenorrhœa of a year's duration or longer. Hysterical convulsions, hystero-epilepsy, even hysterical mania, may have developed. If indigestion and vomiting have been marked features of the case, she is much emaciated; if not, she may appear to be in good flesh, but her muscles will be flabby. There may be tonic spasms of some of the muscles, and even contracture to an extreme degree, the heels being drawn up until they touch the buttocks and the knees close to the chest. Spasmodic twitchings are also frequently present. The countenance is pale and the lips bloodless. Hyperæsthesia and perversions of sensation, especially on the lower extremities, are almost constantly present, often to such an extent that the weight of the bed-clothes cannot be borne. Constipation is obstinate. A narcotic or hypnotic habit of some kind has probably been formed—morphine, chloral, Hoffmann's anodyne, or some other hypnotic, together with an alcoholic stimulant, being taken in inordinate quantities. The whole range of tonic and purgative medication has of course been gone through. The eyes are intolerant of light and the ears of sound, the skin of contact and the stomach of food.

It will doubtless be objected that this picture, like the combination-character photograph, confounds several morbid individualities—that we have here described not simply neurasthenia, but hysteria, hystero-epilepsy, catalepsy, dyspepsia, spinal irritation, and what not. It is precisely because neurasthenia is simply the vestibule to any or all of these conditions that this conglomerate view has been presented. In many instances, if taken in time, these extreme manifestations will never be reached. But it is quite possible for any neglected or improperly managed case of this affection to develop any or all of the symptoms and results above described.

The immense catalogue of symptoms presented by cases of neurasthenia certainly justifies the assertion that this condition is simply a loose term made to cover all conditions of nervous disturbance, accompanied by debility, which we are as yet unable to trace to organic alteration of the nerve-tissue. Idiosyncrasy of course shapes the type which this condition will assume in the individual. Hence the physician must study his cases carefully, not binding them down to one iron-clad routine, and must treat the morale as well as the physique. It is with the latter object in view that he will sometimes recommend seclusion among strangers. A will which has become obstinate in one direction and *nil* in another must be restored to a healthful condition by the influence of a stronger will over it. Such a period of complete separation for a time from her own family, although they as well as the patient will strongly resist it, will enable them to burst

the bonds of a tyranny which destroys the happiness of the home and not unfrequently ruins the health of those nearest and dearest to her.

What shall be the mechanical treatment of such a case as that described? It is well to begin with the extremities which are least sensitive, and these are usually the upper. Passive flexion and extension of the last phalanges should first be made with upward stroking of the whole finger. Then the middle, and finally the proximal, phalanges should be manipulated in the same way. This will be sufficient for the first day. On the second day the flexion and extension will be carried to the metacarpal articulations, and on the third to the wrists. A rotation of each finger and of the wrist will be added. On the fourth the elbow-joint will be reached, and the pronation and supination of the forearm will be made. On the fifth the shoulder will come into play, with movements forward and backward, abduction and adduction and rotation. On each day all the movements of the preceding day are of course repeated.

On the sixth day kneading of the arm and hand will be begun, gently at first and with gradually increasing vigor. By this time there will be noticed a slight improvement in the capillary circulation of the fingers, less blueness in the nails, and less rigidity of the joints. The patient may now, on the seventh day, be instructed to resist slightly the hand of the manipulator in the different movements, and also to make the same movements herself against slight resistance on his part. In urging her to make a specific movement he should precede her effort by carrying the part which she is to move into the extreme opposite direction. This will put the muscle which is about to be used on the stretch, and the slight stimulus thus communicated to it will enable it to contract with more readiness and force. In the same way he should, as he feels that her effort is ceasing, carry on the movement himself to its completion, thus affording the stimulus for the return movement. Whenever he orders a movement to be made he should insist on its completion, even if he must make it entirely himself. Nothing subjects the will of a patient to the physician more quickly than enforced muscular movement. It produces a sense of powerlessness which effectually disarms resistance.

The second week will begin with movements of the toes, proceeded with in precisely the same manner as those of the fingers, and, day by day, additional joints of the lower extremities will be added to those already manipulated, all the hand and arm movements being sedulously kept up. This will complete the second week. We have now made use of passive, active, and duplicated movements of both extremities, compelling both eccentric and concentric contractions of every muscle; we have aided the flow of the blood and lymph toward the heart by our

upward strokings, and have effectually emptied the muscular capillaries and invited fresh blood into them, and stimulated the interchange of elements in their cells by our kneading. The whole process of circulation and tissue-metamorphosis has received an immense impulse, with no corresponding expenditure of nerve-force on the part of the patient. The time has now come to provide more effectually for the removal of the effete material which the blood is becoming charged with, although the flexion and extension of the thighs, acting on the psoas and iliacus muscles and those of the abdominal wall, have not been without a stimulating influence on the pelvic viscera.

The third week opens with a strong respiratory movement, the hands being held above the head and drawn upward, while the patient is urged to inspire deeply, which she finds little difficulty in doing in this position. She then draws her hands down to her sides against the resistance of the operator. The effect of this movement is to pump up the blood into the lungs, heart, and abdominal vessels. We follow it immediately with abdominal massage, using the surface stroking for reflex purpose somewhat sparingly, and relying principally on kneading over the course of the colon. To the kneading of the extremities are now added chopping and fulling. These movements will be continued during the third week. By the end of this week the spinal and cerebral excitability should have been somewhat reduced by the calmative influence of the purer and more abundant nourishment which those centres are receiving, and we may safely proceed to manipulate the spinal region from the base of the brain down to the sacrum. The manipulations will begin with stroking downward and outward from the spine in either direction, covering the entire back. These will be followed by kneading, carefully noting tender points and working around and away from, rather than directly over, them. Chopping and whipping of these surfaces will follow.

Movements of the trunk, flexion and extension, sideward bending and rotation, will now be in order. These will be continued to the end of the fourth week.

With the opening of the fifth week we may venture on clapping over the back and liver and percussion of the spine, the patient being carefully watched during the latter procedure to see that faintness does not result, and the previous caution being observed with regard to tender points.

At the commencement of the sixth week neck-kneading and head-movements, flexion and extension of the cervical spine, side bendings and rotation, and massage of the scalp will be in order. Special attention must be given to the muscles of the neck, enlarged glands, and exudative deposits, muscular adhesions being carefully kneaded, dispersed, and broken up in cases where there has been much headache.

Downward stroking of the neck must be used with caution in anæmic cases.

The following is a prescription for general massage suitable for any case of debility, impaired nutrition, neurasthenia of moderate grade, or similar condition of the system, designed to be tonic and alterative:

1. Half lying, foot rotation, with active flexion and extension.
2. Half lying, leg kneading, clapping, fulling, and stroking.
3. Half lying, thigh rotation, followed by leg extension.
4. Yard sitting, arm kneading, chopping, clapping, fulling, and stroking.
5. Passive arm rotation, with active flexion and extension.
6. Hook-half lying, abdomen kneading, vibration, and colon stroking.
7. Opposite inclined standing, sacrum percussion.
8. Opposite inclined standing, longitudinal and transverse back clapping and stroking.
9. Standing, active arm rotation, with deep breathing.

(*Note.*—"Yard" signifies that the arms are stretched out laterally, horizontally.)

Paralytic Nervous Affections.—It is taken for granted that in other parts of this work the differential diagnosis of the various paralyzing lesions of the brain and spinal cord and of the peripheral nerves will be detailed. It is sufficient for the purpose of this article to say that, in a broad way, those palsies which are associated with muscular degeneration, whether atrophic, pseudo-hypertrophic, or fatty, are most amenable to this method of treatment, and that in these affections we rely principally on movements. Acute central disturbances of an inflammatory character always preclude their employment. But muscular spasm is not necessarily a contraindication. In functional, rheumatic, and hysterical paralyses it is especially indicated. Schreiber says that the value of the Swedish methods is nowhere more strikingly illustrated than in the treatment of palsies. Ordinarily, when active motion has been prescribed, all attempts to give particular exercise to the paretic muscles are rendered nugatory by the simultaneous action of the antagonizers, which easily overpower the weaker muscles. It is an essential feature of the Swedish movement cure that it aims to place at rest the entire muscular system, save and except only the particular set of muscles which it is desired to call into activity, and this whether the movements are given directly by the physician or through the medium of machines.

In the essential paralysis of infancy truly wonderful results are attainable. The treatment should be entered upon the moment the acute inflammatory symptoms, if such existed, have disappeared, and continued daily in the face of seeming absolute ineffectiveness for

weeks and even months. Cases in which no improvement can be detected for long periods often suddenly begin to improve, and progress with great rapidity. The idea which was suggested in speaking of sciatica, of giving the patient a definite object to accomplish, and in this way to stimulate the brain as well as the muscle, acting on the centre as well as on the periphery, is equally applicable here. The other thought, too, of indulging in the pious fraud of aiding the patient, especially if a child, in accomplishing the movement which he is instructed to make, and leading him to think that he has been successful in his effort, will prove a useful one in these cases.

Gowers strongly urges the use of massage in acute atrophic paralysis, whether in the child or the adult. He says: "Another method which should be employed is systematic rubbing of the limbs. This stimulates the circulation, which is always defective, as the blue-cold surface shows. It no doubt also increases the motion of the fluids outside the vessels, and so probably increases the interchange of material. *The muscles should be daily rubbed and kneaded and gently pinched.* The rubbing should be especially upward, so as to expedite the flow of the blood in the veins."

Pseudo-hypertrophic Muscular Paralysis.—In this mysterious affection, in which loss of power is coincident with gradual apparent increase in the volume of the weakening muscle, as well as in its firmness, systematic movements are of the greatest benefit, and no other means offers the slightest prospect of retardation or benefit. The author just quoted remarks: "Muscular exercise does seem to have some influence in retarding the failure of power. It may perhaps cause some growth or increased capacity for contraction in the muscular fibres that have not yet suffered. It is possible, also, that it may, to some extent, divert the trophic energy from the interstitial tissue, since cessation of muscular exercise is certainly followed by quicker failure of strength. Hence it is desirable that the patient should carry out carefully-planned gymnastic exercises so arranged as to call into action the muscles that most need help. These, thoroughly persevered in, have seemed more than any other means to retard the disease. But they have not in any case arrested it. Rubbing and massage are useful, combined with passive movements, in lessening the tendency to muscular contraction and consequent deformities."

Locomotor Ataxía.—This intractable, if not incurable, affection is often greatly retarded in its progress by mechanical methods. Weir Mitchell says: "It is many years since I first saw in this city general massage used by a charlatan in a case of progressive paralysis. The temporary results he obtained were so remarkable that I began soon after to employ it in locomotor ataxia, in which it sometimes proved of signal value, as in other forms of spinal and local disease." It is

in this affection that machine vibrations and stretching of the spinal cord by means of suspension by the head produce astonishingly good results.

LATERAL SCLEROSES, in common with all spinal affections which are characterized by greatly increased irritability and exaggeration of the reflexes, are not benefited by this system. The paralytic conditions following certain acute infectious diseases, such as diphtheria, are often greatly improved under it.

Spasmodic Nervous Affections.—Chorea Sancti Viti, even its graver forms, rarely fails to improve under a judicious course of movement and massage.

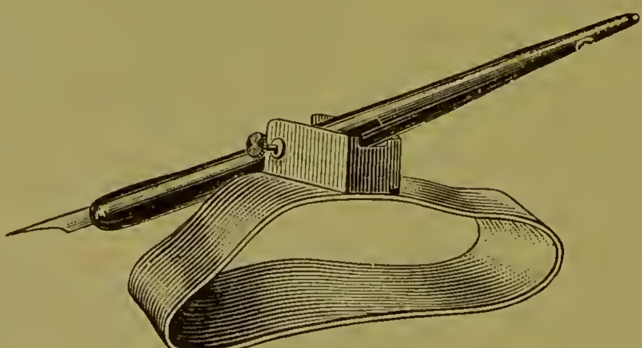
In the year 1854, Dr. Blache presented a memoir to the Academy of Medicine in Paris on the "Results obtained by the Use of Gymnastics and Massage in Chorea," on which Bouvier submitted a very favorable report to the Academy in the year 1855. The manner in which he adapted this method to the treatment of chorea is as follows: At the outset, when the muscular contractions are so powerful that the limbs and trunk are thrown about in the wildest manner, the patient should be placed upon a mattress and held as immovable as possible by three or four attendants for from ten to fifteen minutes. The masseur then begins to perform light stroking with the full palm of the hand over both upper and lower extremities, and also over the chest, gradually increasing the pressure. The patient is then turned upon the face, and the same stroking is given upon the back, especially over the neck and upon the strong muscular masses on either side of the spinal column. Such an application should continue about an hour, and should be repeated in from three to four days. After each treatment the irregular muscular contractions become less violent, and the patient makes it understood by his gestures that he feels more comfortable. Sleep, which has been completely interrupted during the continuance of the most violent contractions, is gradually re-established and speech begins to return. For several subsequent days the light stroking and friction must be persisted in, and the masseur may then begin very regular, rhythmical passive movements. These are to be made with especial care through three principal joints of both extremities. In making these movements there is naturally a not inconsiderable tension of the antagonistic muscles to be overcome, but this gradually yields, and the child is soon in a position to supplement the communicated movements by active muscular contractions. After every sitting the pain which was at first experienced in the muscles from pressure or tension diminishes. When these passive exercises have been continued from eight to ten days the will has so far resumed its mastery over the muscles that the child is able to eat and take a few steps alone, although very totteringly. Active gymnastic exercises are now superadded. These must be the simplest physiological movements of the limbs and trunk,

such as will but slightly tax either the attention or the will. It is a great assistance to have the movements made in front of the patient for him to see, and at the same time to have singing or instrumental music, with a strongly accentuated measure which coincides with the time of the movements. The rhythm and the mimicry are both aids to the control of the will over the muscles. Under the influence of these exercises the child's disposition improves. It becomes more cheerful, companionable, and docile; its appetite is better, its strength increases, and the emaciated, anxious face grows fresh and rosy. By the end of ten or twelve days the improvement usually comes to a standstill, over which point the patient must be helped by persuasion and encouragement. It soon begins afresh, and a radical cure quickly ensues. With the cessation of the irregular muscular contractions the chlorotic condition, which appears to form the basis on which the chorea is founded, as well as the palpitations of the heart and the arterial murmurs, also vanishes.

The cures of chorea obtained in this way appear to be more permanent than those effected by any other course of treatment. Dr. Blache assures us that among the 108 children thus treated up to the time of his report not a single relapse had occurred—a remarkable contrast to the statement of Sydenham, that chorea usually returns in the autumn of the following year. Very recently this method has been recommended by Mills, Goodhart, James, John Phillips, and Busch.

WRITERS' CRAMP.—Massage has recently acquired an especial significance in the treatment of certain forms of cramp which depend

FIG. 120.

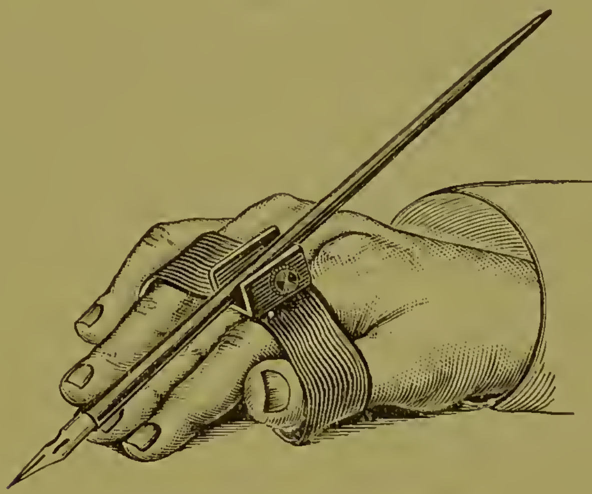


The Nussbaum Bracelet for Writers' Cramp.

principally upon a disturbance of the peripheral nervous system, often as a consequence of undue irritation and over-tension of the affected nerves. Such are twitchings in the regions supplied by the facial nerve and the accessorius of Willis, writers', piano-players' violin-players', telegraphers', and knitters' cramp—usually idiopathic, tonic contractions of certain distinct groups of muscles. The treatment of these forms of cramp consists in strong stroking, percussion, and kneading of the

affected muscles, combined with systematic exercise, both of them and of their antagonists. The little apparatus known as Nussbaum's

Fig. 121.



The Nussbaum Bracelet, as used.

bracelet is not simply a pen-holder, but a form of exercise. Its object is to compel the use of the extensors and adductors of the fingers, and in that way afford a rest to the abductors and flexors, which have been overtaxed.

A German writing-master named Wolff has achieved an immense success in the treatment of this class of cases. He depends much upon active movements of the fingers separately. To accomplish this he fixes the fingers which he desires to keep at rest with rubber bands. A séance lasts about half an hour, and must be repeated once or twice every day.

Diseases of the Locomotor Apparatus.—Myalgia—or, as it is oftener called, Muscular Rheumatism—is probably a neuralgia of the ultimate nerve-fibrils in a muscle. The rapidity of its onset forbids the belief that it is due to an inflammatory process. It is accompanied with stiffness and pain on motion. It is always present in the form of neurasthenia known as spinal irritation, producing points of tenderness which are considered characteristic of that affection. Stiff neck is a familiar instance of it; lumbago is another. Massage, principally in the form of circular kneading and stroking, almost invariably affords prompt relief in the latter distressing and disabling affection.

In the rigid conditions of joints following rheumatism and rheumatic gout this system, in connection with mineral waters and baths, constitutes almost our sole resource. The results which can be achieved by long and patient persistence in its employment are truly remarkable.

Effusions in the joints and along the course of tendons (tendovaginitis) are greatly benefited, and often entirely removed, by combined friction and upward stroking.

In the treatment of all joint affections, and especially of those resulting from injury, what is termed by Reibmayer "introductory massage" is of the first importance. Before the stiff or painful joint is touched, massage of the limb or body above the joint should be instituted, consisting of strong kneading and centripetal stroking. In this way the capillaries and absorbents of the part on the cardiac side are put into a condition of readiness to take up and dispose of the effused material.

SPRAINS.—No traumatic conditions about joints lead to more deplorable results, and none are more amenable to rational treatment, than sprains. A sprain is defined by Busch in Ziemssen's *Handbook of General Therapeutics* as the forced excursion of a joint beyond its normal limit of movement. In consequence, the articular surfaces on the side toward which movement takes place are pressed together, and a point of contact is formed which serves as the fulcrum for the lever which forces apart the opposite portions of the articular surfaces. In consequence of the gap caused by this separation a vacuum tends to form within the joint, but this is prevented by the soft periarticular tissues being forced in by atmospheric pressure. At the same time, the tendons and ligaments are violently extended and may be even slightly torn. The moment the force is removed the articular surfaces instantly approximate again, occasionally including folds of synovial membrane between them, or displacing the interarticular cartilages when these exist. The pain caused by the sprain is the natural result of these mechanical disturbances. It occasionally happens that the sheaths of the tendons are ruptured, and the tendons themselves sprung out of place and over some bony prominence.

Having thus laid down the exact nature of the sprain, he divides the object to be achieved by mechanical means into two divisions, founded on pathologico-anatomical considerations.

1. *Restoration to their Normal Relations of all the Component Parts of the Joint.*—He cites here the practice of one of the older French surgeons, Ravaton, who, whenever called upon to treat a recent sprain if swelling had not yet taken place, had the joint forcibly put on the stretch by two strong men pulling in opposite directions, while he clasped his hands about it, locking his fingers and making firm pressure on every side in order to force into place any bones that might have become dislocated. Then, after replacing such tendons as had slipped from their grooves, he applied a bandage. This restitution of all the parts to their normal environment is especially important in joints possessed of semilunar cartilages, for they are particularly liable to be displaced by sprains, and to remain caught between the articular ends of the bone—a condition called "internal derangement" by English authors.

2. *Removal of the Spastic Muscular Contractions.*—After a muscle has been put violently upon the stretch it reacts, and a state of tonic

spasm ensues, which is not only painful in itself, but doubly so in these cases on account of the forcing together of the articular surfaces which it causes. This spasm may, however, be quickly dissipated by gently rubbing the muscle.

In treating a sprain of the ankle we begin with gentle centripetal rubbing, using first the finger-tips, then the whole surface of both hands, commencing at the toes and gradually proceeding upward as far as the painful spasm reaches. As the pain diminishes more and more force may be employed, and when the contraction has so far relaxed as to leave the joint movable, gentle flexion and extension of the foot should be performed. A flannel roller carried above the ankle should then be applied. After the second or third sitting the movements of the ankle-joint will generally be quite free and almost painless. The patient may then be allowed to walk a few steps. Should this not be followed by an increase of pain, the amount of exercise may be cautiously increased until full use is re-established, watching closely all the time for the first signs of any inflammatory swelling.

Graham points out that the sooner the treatment is commenced the shorter is its duration. The advantages resulting from massage are speedy relief of the pain and swelling and earlier and more perfect use of the limb and joint. Bergmann treated successfully by massage no less than one hundred and forty-five cases of recent traumatic joint affections, including contusions, sprains, and synovitis with effusion. Seventy cases affecting the ankle-joint recovered on an average in six days, whilst thirty-eight cases of old sprains required twenty-two days each. It was found that after a plaster-of-Paris dressing had been applied even for a very short time the duration of the treatment was much prolonged. Nélaton, Sée, Demarquay, Labbe, Duplay, and others speak highly of the value of massage in affections of the ankle-joint. Dr. Roux of Lausanne says that it acts almost like magic in cases of synovitis, whether of rheumatic origin or resulting from an injury. In the Prussian army, where treatment by massage is in certain cases obligatory, it is found that the average duration of the disability from sprains not treated by massage is twenty-seven days, whilst when masso-therapy is resorted to it is only nine days. These results, based on the observation of a large number of cases, are very striking.

Murrell calls attention to an interesting chapter on massage in an excellent work on *Sprains* by Mr. Mansell Moullin. The author, after describing the methods of procedure, points out that the best proof of the power possessed by massage over absorption and circulation is shown by the ease with which swelling and tension can be made to disappear from sprained joints. "In recent cases," he says, "the greatest care is required, and nothing is so likely to increase the mischief as

rough handling of the part; but when it is carried out quietly and gently by one who has had some experience, it is very difficult to find anything that acts in so perfect a manner. The whole limb perhaps is swollen, the joint distended with blood, the skin shining and tense, much too hot to the touch, and exquisitely tender, but all this vanishes as if by magic. The tension disappears as the fluid is carried off, the pain is relieved, the temperature falls, the natural outline begins to appear once more, extravasated blood is broken up, the débris dispersed, and adhesions between the torn and bruised surfaces effectually prevented. Sometimes even tendons which have been turned almost out of their grooves by the accumulation of fluid in their sheaths can in this way be restored to their positions without further assistance. Such results as these cannot of course be obtained in every case of recent sprain, and even when the treatment is successful in relieving the pain and getting rid of the swelling, it must always be remembered that time is needed for the repair of structures that have been torn. I am convinced, however, that especially when the stress of the injury has fallen on the muscles, and when the laceration is not too great, this plan may be adopted not only with the greatest safety, but with an infinitely better prospect of speedy recovery than under the old-established method of bandaging and rest." Speaking of more chronic cases, where the effusion is denser and firmer, and where, owing to the long-continued distension, the tissues have lost their tone and become sodden and œdematous, the author recommends that massage should be applied with greater freedom. "The solid part of the effusion is broken up and disintegrated by the pressure, so that it is driven into the absorbents and carried away by the increased force of the stream; the chronic congestion is dispersed, the blood circulates more freely, the tone of the part returns, and the lifeless, helpless look disappears day by day. The improvement is often surprising in its rapidity. A joint that has remained for weeks cold and inactive, the seat of a constant wearing pain, and quite incapable of performing its proper movements, in a very few sittings begins to recover its flexibility, loses the pain, and allows itself to be handled, and passive movement to be carried on with ease and readiness." Mr. Mansell Moullin finds that the most striking results are furnished by cases which have been treated by bandaging in the conventional way, where the œdema still persists and where there are no adhesions other than those resulting from rigidity of the capsule and the swelling of the soft tissues.

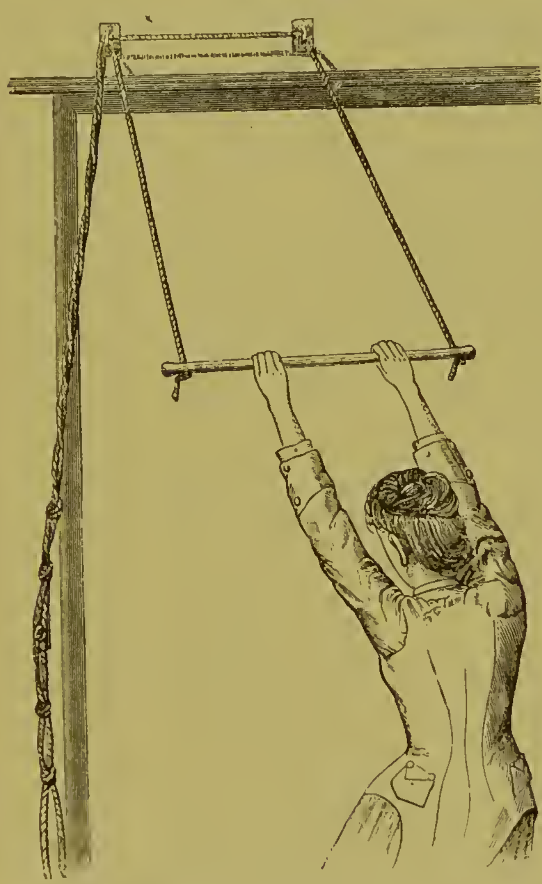
Graham has analyzed the results of 308 cases of sprains treated by massage by himself and several independent observers in Europe. These represented all grades of severity and all varieties of injuries of this general nature. He finds the average length of time for recovery to have been 9.1 days. This average would have been

much diminished if 39 cases in which massage was not begun until from two to twelve weeks after the receipt of the injury had been omitted from the calculation. A study of 55 cases treated in the usual manner by fixation by the same observers showed the average time for recovery to be 26.16 days, or nearly three times as long as similar cases treated by massage.

It is perfectly safe to assert that, as a rule, if a sprain is taken in hand by a competent masseur immediately after the receipt of the injury, and masséed twice or even thrice daily, the time which will be required for perfect recovery will be to that which would be required were it encased in an immovable dressing as a week is to a month. This is indeed a very moderate statement.

It was said by Prof. S. D. Gross that a majority of the cases requiring amputation were the result of sprains. If this be so—and the assertion is supported by European surgeons—then it is difficult to over-estimate the importance of an early resort to this method in every such injury.

Fig. 122.



Vertical Suspension by the Hands, by means of the trapeze, as used in lateral curvature.

Fig. 123.

Self-suspension by means of Dr. Lee's Spinal Swing.

Lateral Curvature of the Spine.—Among the disturbances of muscular irritability and equilibrium, lateral curvature stands prominent. Occurring quite independently of any known mechanical cause,

such as collapse of one lung, traumatic or sequelar abscess of the spinal muscular system, inequality in the length of the legs, paralysis of one arm, and so on, it usually assumes the double or sigmoid form. It is a disease of early childhood, and is much more common in females than in males.

Mechanical therapeutics constitute the only means for its treatment. They are administered with a view to stretching the contracted muscles, developing their overstretched antagonists, improving the general muscular tone, and overcoming distortion. Spinal self-suspension is a valuable exercise for this purpose.

The following is an ordinary prescription for double (sigmoid) right lateral curvature of the spine (upper convexity to the right, lower to the left):

1. Inclined thigh support standing, left arm extension, with double side-pressure.
2. Left-neck rest, inclined thigh support standing, back extension, with double side-pressure.
3. Hanging head backward bending, double side-pressure.
4. Left-neck rest, inclined stride sitting, back extension, with double side-pressure.
5. Hanging, leg abduction and adduction.
6. See No. 4.
7. Left stretch right side lying, stretch holding.
8. See No. 2.
9. See No. 4.
10. See No. 7.

After each movement, standing arm raising forward, upward.

The following is an ordinary prescription for lateral curvature of the spine (single convexity to the left):

1. Inclined thigh support standing, right arm extension, left side-pressure.
2. Right neck rest, while right hip support standing, left, sideways flexion, left side-pressure.
3. Neck rest standing, heels rising.
4. Right stretch right underlying, holding.
5. Right stretch lying, left hip upward pressure.
6. Right neck rest standing, left sideways flexion, left side-pressure.
7. See No. 5.
8. See No. 4.
9. See No. 2.

After each movement, standing, arm raising forward and upward, outward and downward.

(*Note.*—"Neck rest" signifies, having the hands joined behind the neck. "Half neck rest," having one hand in that position.)

Diseases of the Respiratory System.—While it is true that Kelgren and others have published cases of pneumonia which they claim to have cured by massage, the general law, that except as a means of soothing nervous excitement and aiding sleep this therapeutic means is not applicable to acute affections of the vital organs accompanied by febrile reaction, must hold good in reference to that disease. In chronic congestions, however, it may accomplish much good.

Relief is often given to a notable extent in pulmonary asthma by chest percussion and vibration, and forced expiration.

Dr. C. T. Williams, in his work on *Pulmonary Consumption*, says that under the influence of massage appetite and digestion improve and the circulation becomes more vigorous, color returns, and the quantity of food consumed is sometimes astonishing.

Dr. Thomas J. Mays, in a paper on the "External Therapeutics of Pulmonary Consumption," gives the result of his experience in the use of massage in consumption as follows: "Last winter I witnessed a series of very interesting experiments on the physiological effects of massage which were made by Dr. Zabludowski under the direction of my friend and teacher, Prof. Kronecker, in the Physiological Laboratory of the Berlin University, where I was engaged in physiological work at the same time. The results of his experiments, which have since been published in the *Centralblatt für die medizinischen Wissenschaften*, No. 14, convinced me that massage had a tonic and invigorating influence upon the animal body; and during my attendance last spring at the Brompton Hospital for Consumption, in London, I related those experiments to Dr. Bruce of the hospital staff, and he concurred with me in the belief that bodily massage, by arousing the constitutional lethargy present in phthisis, might probably be a valuable adjunct in its treatment. Since my return I have had opportunities to test the efficacy of massage in a clinical way, and it has certainly proved itself to be a most useful addition to the external therapeutics of pulmonary consumption."

It is an error, however, in this disease to attempt to "expand the chest," as it is popularly called, or to make use of very strong respiratory movements. Such efforts may increase congestion, and even provoke hæmorrhage. The advantage to be gained is the general invigoration and improvement of nutrition.

Vocal Gymnastics.—The systematic exercise of the voice according to certain definitely prescribed rules has a far wider effect than the mere strengthening of the vocal organs. This should consist in repeating after the instructor all the articulate sounds of a language: first, the vowel sounds; then the vowels in combination with the simple consonant sounds; and, finally, the most difficult compound consonant sounds. Care should be taken that the mouth be well open, the lips

thoroughly retracted, the head erect in order to open the throat, and the chest well expanded. The exercise should be conducted with sufficient rapidity to slightly accelerate the speed of respiration, and the enunciation made with a sudden and energetic expulsion of the breath. Any one who will go through a solid hour of this drill will find that he has been working. But at the same time, if the severity of the exercise has been properly proportioned to his strength, he will feel a general sense of invigoration rather than of exhaustion. This is due to three distinct causes: First, he has taken into his lungs a very much larger amount of air than he is in the habit of doing. Thus the blood has been able to get rid of its impurities at a more rapid rate, and every tissue of the body has received a fuller supply of healthy nutritive fluid. Secondly, all the muscles of the trunk, but especially the abdominal muscles and the diaphragm, have been called into vigorous action; their circulation has been quickened; a greater amount of blood has been invited into their capillaries; plethora of the abdominal viscera has thus been relieved and nervous irritability diminished. In the third place, the mechanical action of the diaphragm and abdominal muscles upon all the abdominal organs has been such as to subject them to alternate pressure and relief from pressure, thus directly stimulating their circulation and expediting the flow of their secretions and excretions. Thus, not only has the blood been made more fit for the nutrition of the body, but its distribution to every part of the system has been greatly aided and the discharge of effete matters has been promoted. It is not difficult to imagine that an agency capable of calling into play such important activities may possess therapeutic virtues. And such is actually the case. Individuals suffering from general debility, feeble respiration, dyspepsia in several of its forms, constipation, nervous irritability, palpitations of the heart, and narrowness of the chest have been greatly benefited by this gentle but efficient form of muscular exercise.

In Croup, both *true* and *false*, centripetal stroking of the neck in the manner already described is useful—in the former, by producing local depletion and mechanically aiding in the dislodgment of the membrane; in the latter, by soothing the spasm of the vocal cords and laryngeal muscles.

In acute catarrh of the nose and throat, neck-massage is capable of giving great relief and of shortening materially the duration of the attack.

Diseases of the Female Reproductive System.—In all pelvic engorgements, whether of the uterus, ovaries, or appendages, and in all uterine functional derangements, massage and movements, but especially the latter, are a very valuable adjunct to other means of treatment. Retarded or suspended menstruation can usually be brought to time by

strong movement implicating the psoas and iliacus muscles and the adductors of the thigh. Both the uterus and the ovaries can be reached and manipulated through the abdominal walls. Any additional advantage to be obtained by manipulating these organs directly through the vagina, as recommended by Reeves Jackson and others, is not sufficient to counterbalance the serious objections to the procedure on the score of delicacy and the risk of inducing involuntary erotic manifestations on the part of the patient. In all prolapses, whether of the uterus or ovaries, the assumption of the knee-breast posture for a short time daily, the patient being instructed to open the vagina in order to allow of internal atmospheric pressure, should be enjoined. If taken for a few moments the last thing on retiring, it will often ensure a good night's sleep. Another mechanical resource for the same purpose is to have the foot of the bed a few inches higher than the head.

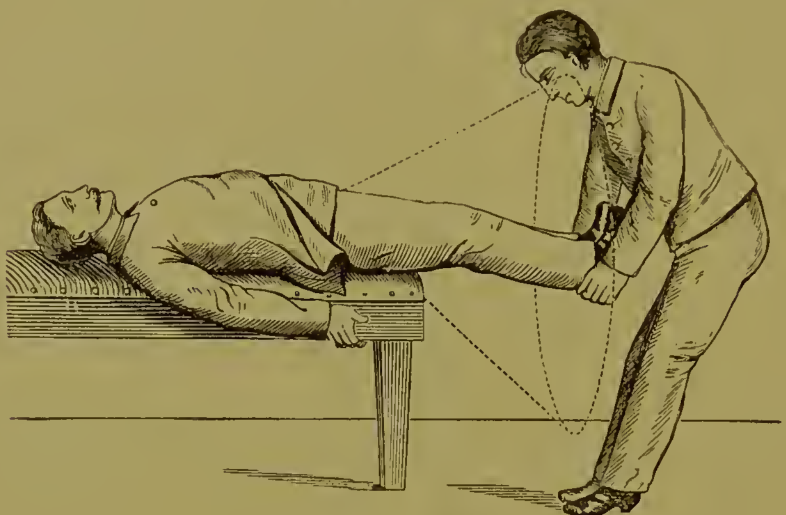
Ovarian Dropsies which have resisted all other methods have sometimes yielded to the employment of abdominal massage. Such a case has been reported by Von Winiwarter: Reasoning from the experience he had had in removing fluid from œdematous limbs, where its absorption by the blood had caused secondarily increased diuresis, which finally led to the entire elimination of the fluid from the body, he assumed that the cyst fluid, which has a low specific gravity, could be likewise removed by mechanical means. While not attempting to decide the question as to whether the fluid is absorbed by the lymph-vessels or the blood-vessels, he combats the idea that resorption is not due to the immediate manipulation of the cyst itself, but rather to the stimulation of the circulation as a whole, which, by leading to increased diuresis, necessarily involves an increased absorption of the cyst fluid. If this latter explanation were the correct one, he maintains, mechanical treatment would be equivalent in its effects to that by diuresis and purgation, yet it is a universally acknowledged fact that the ovarian fluid remains unaltered in quantity even after the most vigorous and prolonged use of diuretics and cathartics.

His mode of treatment of this class of cases has been criticised as involving many difficulties, and being, at the best, but palliative. But to this he replies by showing that in this case massage was of more effect than repeated tapping—that it had not only prolonged life, but had made it as bearable as it possibly could be made without resorting to radical operation. Von Winiwarter therefore regards massage as indicated in all cases of ovarian cyst where from any cause operation is impracticable.

Diseases of the Urinary and Male Reproductive Organs.—The kidneys are so situated as to be quite easily reached by the direct influences of massage and the indirect action of movements of the pelvic and spinal muscles. Even in organic affections, as the various Bright's

diseases, congestions may be relieved and normal circulation promoted in these organs. Dowse has found massage of "the kidneys when they contain gravel and calculi most useful. Deep kneading and percussion

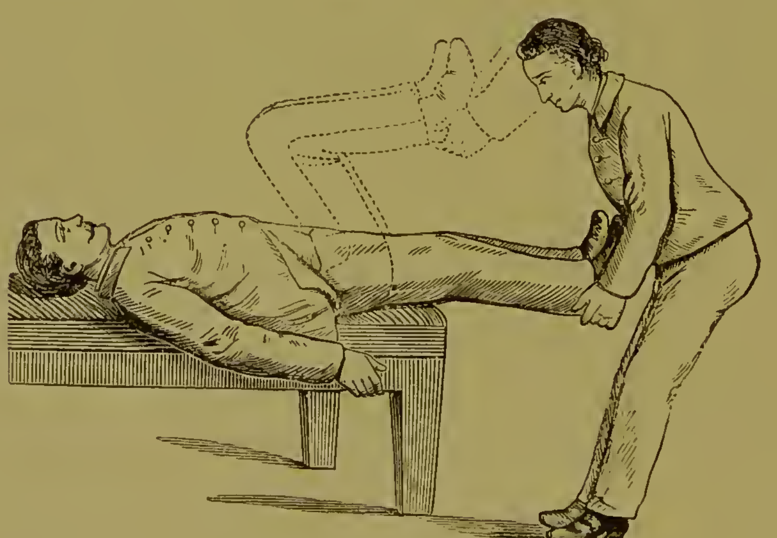
FIG. 124.



Lying, hip rotation.

are necessary, and the operation should be performed daily for a period of two or three months. The attacks of severe pain diminish in fre-

FIG. 125.



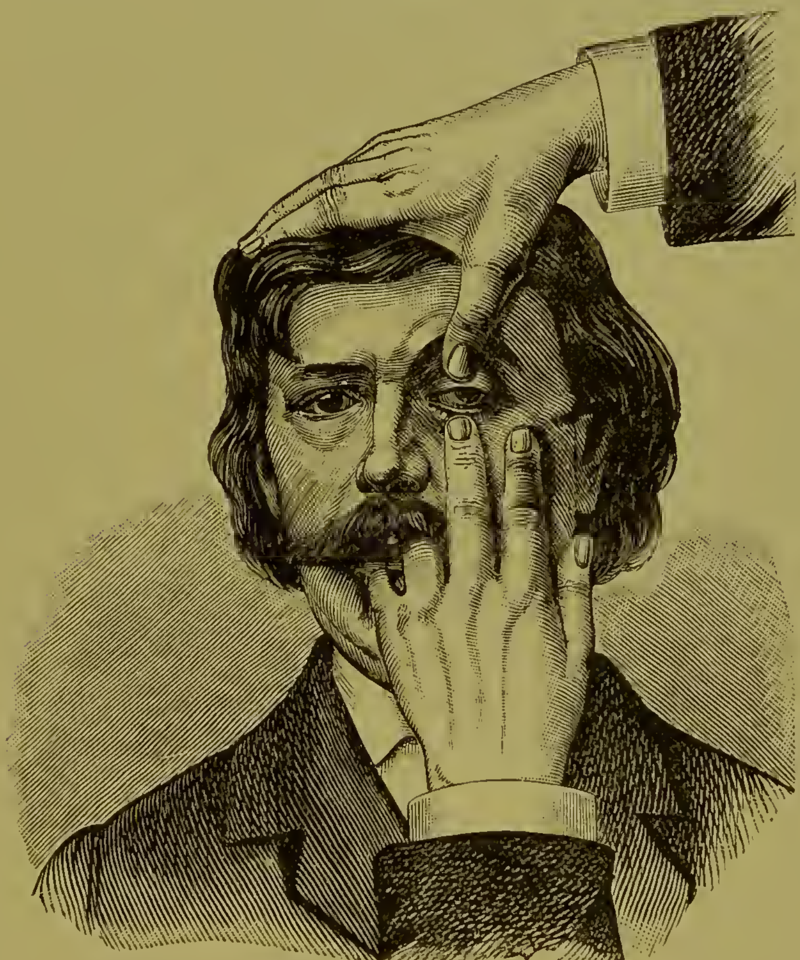
Lying, knee-chest flexion and extension.

quency and intensity, and eventually the stones are passed into the bladder."

The relaxed condition of the tissues about the perineum and the crura of the penis which accompanies, if it does not lead to, SPERMATORRHŒA, is capable of remedy by the judicious exercise of certain muscles.

Diseases of the Eye.—The tendency on the part of oculists, as well as of mechano-therapeutists, to make use of massage in the treatment of many affections of the eye is very manifest at the present day. Prof. Costomoris of Athens has obtained excellent results from its employment in the following diseases: acute or chronic follicular conjunctivitis, catarrhal conjunctivitis, œdema, ecchymoses, phlyctenular

Fig. 126.



Massage of the Eye.

ophthalmia, gonorrhœal ophthalmia, croupous and diphtheritic ophthalmia, parenchymatous keratitis, infiltrations, abscesses and ulcers of the cornea, and opacities of the cornea. It was first proposed by Donders in 1872. Landolt uses it, together with boracic acid, in granular affections of the conjunctiva and cornea. Holmes has found its results in pannus extremely rapid, the duration of cases being reduced from weeks to as many days. He attributes these remarkable results to the increased arterial and venous circulation, the breaking down of degenerated epithelial masses, and forcing open occluded lymph-channels, thereby preparing the way for the rapid absorption of pathological products. It will be remembered that it is precisely in this way that the effects of massage on diseased joints are accounted for.

Pagenstecher was the first to reduce massage of the eye to a system. He recommends that the lid which is not being treated be slightly retracted with the middle finger of the other hand. He uses both circular and radial friction, but depends more on the latter. Opacities that had lasted for over thirty years have been removed in this way. The operation should continue about five minutes, and be performed once daily. Episcleritis has yielded rapidly to this method. Klein, encouraged by Gradeniga's demonstration that the intraocular pressure could be diminished by massage, has used it in glaucoma with encouraging results. He considers it allowable, first, in acute and chronic glaucoma, beginning with inflammatory symptoms and accompanied by increased intraocular tension; second, cases in which sclerotomy and iridectomy have proved ineffectual; third, glaucoma accompanied by continual neuralgia, rendering operation impossible; and, fourth, cases in which operation seems directly contraindicated, as in the hæmorrhagic form.

Diseases of the Skin.—Considering the efficacy of massage in restoring a dry, harsh skin to a condition of softness, pliability, and healthy moisture, it is somewhat to be wondered at that so little effort has been made to utilize it in the treatment of diseases of the skin.

Von Mosengeil, it is true, mentions having treated a few cases of elephantiasis with benefit by massage in combination with light bandaging. But the more ordinary cuticular affections seem to have had very little attention paid to them by masseurs.

The only dermatologist who has taken the matter up seriously is Shoemaker. He tells us that in certain morbid states of the integument, when properly used, it is attended with a most beneficial effect, and often results in restoring the surface to its natural condition. Among the special affections in which he has found it useful are psoriasis, scrofuloderma, and trophic disturbances, in which it increases oxidation, removes effete products, and acts as a local as well as a general tonic, increasing the red corpuscles. It is particularly, however, in chronic eczema that he has seen admirable results from its employment. Even when the integument has become quite leathery the application of massage breaks up the exudation, stimulates the absorbents, and removes the inflammatory products. In the dry form of seborrhœa, in loss of hair, indurated acne, glandular swelling, and abnormal pigmentation it has proved of great service. As is well known, many chronic affections of the surface depend on an unhealthy condition of the mucous membrane of the digestive tract, constipation, and so on. The writer referred to points out that in relieving these conditions massage and movements contribute largely to the cure of the former.

Narcotic Poisoning.—The employment of massage and exercise

in the treatment of acute poisoning from opium and other narcotics dates back beyond the memory of man. Its mode of administration has been of course crude. Its object is twofold—to keep the attention aroused, and in this way prevent the brain from yielding to the fatal lethargy; and to promote in every possible way the elimination of the poison by the various emunctories. Percussion in all its forms, especially clapping and flagellation, neck-massage, head-movements, and general massage, are all indicated, the patient being kept as much as possible in the erect posture and in motion. Chloral poisoning has been successfully treated in this way.

Chronic narcotic poisoning or the opium or other habit is greatly benefited by it. Murrell "knows of nothing which so effectually allays the craving for the drug, and enables the patient to dispense with its use, as massage."

In conclusion, if massage and remedial exercises can accomplish the results claimed for them in the foregoing pages, the system is one which the physician should not consider as outside of the line of regular requirement, but rather one with which every medical student and young practitioner who still has time for study should feel it to be his duty to familiarize himself. The country practitioner especially, who cannot avail himself of the services of a trained masseur, would constantly find it greatly to his interest and profit to be able to treat appropriate cases in this way. The physician in full practice, however, will not be able to devote the necessary time to it, particularly in large cities. To whose care shall he confide the patients whom he desires to have treated in this way?

It would seem almost superfluous to say that the most important qualification should be a thorough knowledge of the art. And yet the first inquiry of the physician is too often, Who will do the work cheapest? When we compare the three years' course required in Sweden, and the few days' instruction, or perhaps simply careless observation, which is often thought sufficient in this country to enable an uneducated person to "pick up" massage, can we wonder that in the former country it enjoys the entire confidence of the profession and the public, while in our own it is barely recognized by the mass of the profession? It is not too much to require that no one, of either sex, shall attempt to perform remedial manipulations upon our patients who does not possess a knowledge of the leading facts in anatomy, such as the position and comparative size of the various organs, and the position and course of the larger blood-vessels and nerves, and of such facts in physiology as the functions of the organs, the course of the circulation, and the nature of the processes of digestion, assimilation, and nutrition—of the modes of applying massage and move-

ments in such a way as to secure the best results in the briefest time, and with the least discomfort to the patient; of the effects produced locally and generally upon the system by the different methods of procedure; of the order in which they should be used; and of the injury which may be inflicted by employing them improperly or in inappropriate cases. No one is competent to acquire such knowledge who has not had a certain amount of education.

In order to be acceptable to the patient, the masseur or masseuse should be quiet in manner, pleasing in address, and scrupulously neat in person and attire. Vigorous health, muscular strength, and a soft and pliant hand with not too moist a palm, are matters of much importance as regards the physique. To these endowments of nature and education must be added a manual dexterity in the application of the various procedures which can only be acquired by careful training under an experienced instructor. Hence it will be understood that the stable and the laundry are not, on the whole, as many physicians appear to think, the best schools from which to graduate practitioners of this art.

In the preparation of this article, which is necessarily somewhat encyclopædic in its character, free use has been made of the works of Drs. Joseph Schreiber, William Murrell, Douglas Graham, G. Norström, and Albert Reibmayr. The writer desires to make this general acknowledgment to these authors, in case their names have not been mentioned in every instance in which they have been quoted.

GENERAL EXERCISE.

By EDWARD MUSSEY HARTWELL, Ph. D., M. D.

All remedial measures which are not blindly traditional are of necessity based upon and prompted by physiological conceptions. The fundamental conception of modern physiology regards the living body as a physical mechanism "whose proper working," to borrow Huxley's words, "we term health; its disturbance, disease; its stoppage, death." It is therefore not surprising that therapeutical measures should become somewhat more direct and mechanical in their character as our knowledge of the nature and course of the various activities and perturbations of the body is extended and rendered more and more precise. Surgery is now coequal with medicine, its base mechanical origin being no longer remembered against it. Hydrotherapy having been rescued, in a measure, from the control of laymen, has, at least in Europe, been accorded a corner in the domains of legitimate medicine. The emancipation of mechano-therapy, which of old stood above surgery, and on a par, to say the least, with hydrotherapy, is of more recent date, and has been less complete, especially among English-speaking peoples.

The term mechano-therapy and the class of procedures denoted by it are so uncommon, or little thought of, in the British Isles and America as to be practically neglected in the dictionaries of Dunglison and Quain. The term "mechano-therapy" has, however, the sanction of foreign usage, and is defined in the *National Medical Dictionary* of Billings as "the treatment of disease by mechanical means, such as massage, exercise, etc." We may use the term, then, to denote medical gymnastics or exercise and massage, though some writers employ it to denote massage alone.

The ends of exercise are essentially the same whether it be employed for recreative, hygienic, educational, or purely remedial purposes. To make rational and proper use of it, for any of the purposes named above, one must have a clear conception of the physiological principles of exercise, to begin with. It behooves us, then, at the outset, to consider somewhat closely the nature and effects of exercise.

It is interesting to note that our word exercise, and *exercitus* the Latin word for the body of best-trained men in the state, the army,

are derived from the same verb, *exerceo.* The Greek synonym for *exerceo* is *ἀσκέω*, and meant originally to work raw material. In classic times it meant to exercise, to train in the strict athletic or gymnastic sense; later, in the early days of the Church, it signified to discipline the flesh, to mortify the body, and to it in this sense the English word "ascetic" owes its origin and present meaning. The original ascetic was simply an industrious and careful gymnast or athlete.

The best comprehensive definition of exercise, that has come under my notice, is that given by Du Bois Reymond, professor of physiology in the University of Berlin. "By exercise we commonly understand," he says, "the frequent repetition of a more or less complicated action of the body with the co-operation of the mind, or of an action of the mind alone for the purpose of being able to perform it better." Practically, all human actions are comprised under the two heads of this definition of exercise. Bodily actions demand our chief consideration.

It is far easier to underrate than to exaggerate the part which muscular actions play in human life. Imagine the condition of a man perfectly formed, generously endowed, and in his prime, whose single lack should be that sensible warm motion that has its seat in the muscular tissue. The position of a fly in amber would be lively and preferable to the isolation of such a man. Of course he could not "do business," but he could think and fear and hope. He must face the future, lying like a log in whatever position he may happen to fall. His face will be absolutely destitute of expression, and his eyes fixed under closed lids. He can neither smile nor weep. His hunger cannot be appeased nor his thirst slaked. His heart may "burn within him," but it shall not pump blood, so that he will be pulseless as well as breathless and bereft of speech. Unable to stir the tip of a finger or to raise a hair, he will be powerless to express his thought or aspiration, or to impress his conceptions or wishes upon any creature. In short, such a man would be an incorruptible cadaver.

Without muscular tissue, then, we cannot live or move. Its importance to the body is also to be inferred from its mass and weight. Nearly, if not quite, one-half of the human body, by weight, is made up of so-called voluntary muscles. The skeletal muscles, moreover, are estimated to contain one-quarter of the blood in the body; and it is through their activity that a large portion of the potential energy of the body is turned into work and heat.

A freshly-dissected skeletal muscle of one of the higher animals presents a smooth surface, rounded outlines, and a glistening appearance, due to its sheath of connective tissue. Inward prolongations of this sheath pass into the substance of the muscle, and divide it into

bundles of fibres, technically called fasciculi or packets. Each fasciculus consists of a number of fibres running parallel to one another. The fibres are separated from one another by connective tissue, just as the fasciculi are. The muscle-fibre or cell is the ultimate and essential anatomical element of muscular tissue. Each fibre consists of a soft, contractile, semifluid substance contained in a tubular sheath—the sarcolemma, which is transparent, tough, and elastic. Fibres vary in diameter from $\frac{1}{600}$ to $\frac{1}{100}$ of an inch, and are seldom longer than $1\frac{1}{2}$ inches. These fibres or cells are arranged in linear series and do not inosculate with each other. The amount of shortening in a contracting muscle is equal to the summated contractions of its individual fibres.

If we lay bare a muscle in a living animal, we may cause it to contract before our eyes, either by bringing a heated body close to it; by giving it a slight tap; by applying certain chemical substances to it, such as ammonia, lime-water, or a solution of common salt; or by giving it an electric shock.

When a muscle outside the body is acted upon suddenly by an appropriate stimulus, it quickly shortens, and then, if it has been loaded with a weight, rapidly returns to its former length. A weighted muscle outside the body, or one in the body which acts against resistance, does work every time it contracts. Its work is chiefly of the sort which physicists have named mechanical work, and is equal to the product obtained by multiplying the weight lifted by the distance through which it is lifted against the force of gravity. Its measure is expressed in foot-pounds. A muscle with no weight attached does no "work" when it contracts, nor does it do any work if it is loaded with a weight too heavy for it to lift. Of two muscles equal in cross-section, the longer can do more work; whereas if two muscles are of equal length, that which contains the greater number of parallel fibres will do more work than the other. It is estimated that a square centimetre of human muscle can just lift a little more than twenty pounds. Muscles are somewhat elastic, and in the body are slightly overstretched.

Besides its contractile substance, its tendons, and the sheaths which invest its fasciculi and fibres, every muscle has blood-vessels and nerves, whose functions must be considered before we can arrive at a clear understanding of muscular exercise. Muscle-arteries and veins usually lie alongside of each other in the connective tissue which surrounds the fasciculi, while their capillaries form a fine meshwork of vessels, lying between and upon the muscle-fibres, but without penetrating the sarcolemma of any fibre. Along with the blood-vessels, lymph-capillaries are found in the interstices of the connective-tissue sheaths of the muscle-fibres, and of the tendons also. The lymph in these spaces is derived by transudation from the blood-capillaries on the one hand, and from

the muscle-fibres on the other. The fibres are therefore bathed in lymph, and derive their food-supply from it by absorption through their tubular sheaths. From this state of things there results an inward and outward stream or interchange of material between the muscle-substance and the blood through the capillary wall, the lymph-spaces, and the sarcolemma.

The nerve-fibres found in the muscles are of two sorts: the white or medullated, which are distributed to the muscle-fibres; and the gray or non-medullated, which are distributed to the plain muscle-fibres contained in the muscle-arteries and veins. The motor nerve belonging to a muscle usually enters the muscle at its middle point. It then divides and subdivides into so many branches that every muscular fibre receives a nerve-fibre. Where the nerve-fibre pierces the sarcolemma the axis-cylinder spreads out, forming an eminence of protoplasm within the sarcolemma. This eminence is known as the "motorial end-plate." The branches of the axis-cylinder traverse this end-plate, and subdivide into fibrils which penetrate the contractile substance of the fibre. Only the axis-cylinder of the nerve passes within the sarcolemma, since the outer sheath of the nerve-fibre coalesces with the sarcolemma itself, and the medullary sheath ends at the sarcolemma.

We have, then, the contractile substance of the muscle-fibre connected with the irritable stimulus-generating and transmitting substance of a central nerve-cell, situated in the spinal cord or the brain, the connecting link being the axial fibre of the motor nerve, which is simply a portion of the nerve-cell's contents long drawn out in the form of a strand, until it reaches the muscle-fibre, where it spreads out to form the end-plate, and then subdivides into fibrils which penetrate the muscle-substance. What is true of a single muscle-fibre is true of all the fibres in a given muscle; and what is true of one voluntary muscle is true of the entire five hundred. Voluntary muscles have sensory as well as motor fibres. They are the channels for the impulses which give rise to muscular sensibility, and are connected with centrally-situated nerve-cells which minister to our muscle-sense — the sense, that is, which keeps us informed concerning the condition of the muscles and the extent to which they are contracted.

A single muscle, then, is to be considered as an aggregation of a vast number of contractile fibres arranged in myriads of linear series, which in turn are gathered into bundles, all of which, along with their accompanying nerve-fibres and nutrient blood-vessels, are supported and bound together by means of elastic connective tissue. The muscle, so made up, has its own special sheath, and is bound by its inelastic tendons to the bones which it is set apart to set in motion. Muscular contractions can be brought about through the direct applications of chemi-

cal, thermal, mechanical, or electrical stimuli to the muscle itself. If the nerve of a muscle be excited by pinching it, by beating it, by applying certain chemicals to it, or by electrifying it, the muscle is indirectly stimulated to contract by means of the motor impulses discharged into it through its motorial end-plate. The motor nerve may be stimulated at any part of its course. Again, the muscle may be set in action through stimulation of the centres whence its nerve-fibres emerge by any of the stimuli mentioned above. Normally, the muscle-centres are stimulated chiefly by "volitional" stimuli.

The effects of exercise upon a muscle and the parts connected with it next demand our attention. Immediately a muscle begins to contract, under whatever stimulus, the blood-stream passing through it becomes changed, both in respect of quantity and quality. The arterial twigs which ramify within it dilate; more blood is poured into the capillaries surrounding its fibres; more lymph passes to the muscle-substance; and the outgoing streams of lymph and blood, in the lymph-capillaries and veins respectively, are augmented.

The blood which enters the muscle is bright red in color, rich in oxygen, and poor in carbonic acid. That which leaves it is dark blue in color and of a higher temperature, richer in carbonic acid, and poorer in oxygen, and contains various products having an acid reaction, due to the chemical changes which take place in the food-material supplied to the muscle-substance, and in the muscle-substance itself. If the supply of arterial blood to a muscle is cut off or diminished, its irritability is lowered; that is, a stronger stimulus is necessary to make it contract. The same result follows, also, if it is fed with blood deprived of oxygen or otherwise poisoned, or if the muscle-vein is tied and the waste-products, normally drained off through the veins, are retained within the muscle. The irritability of a muscle is also lowered by prolonged stimulation, even when its in-going and out-going blood-streams are unobstructed. If these disturbed conditions do not persist until the muscle-fibres pass into the condition known as death-stiffening, the irritability of the muscle may be restored, either by sending fresh blood through it, by sending a stream of some indifferent fluid through it, or by ceasing to stimulate it.

In the first case, restoration is brought about through the renewal of its supply of food-material and oxygen; in the second, by clearing out the noxious waste-products; and in the third, by allowing it to rest a while. These, then, are the main conditions demanded for the health of a working muscle: A full supply of proper food and oxygen; unimpeded and sufficient drainage; and rest at due intervals. Given these three conditions in the body, and exercise of a muscle causes it to increase in size and weight, within certain limits, through the increased size and number of its fibres. Furthermore, a working muscle differs

from a resting muscle in that it is appreciably hotter; by the presence of a low murmur, called the muscle-sound, which is caused by the more rapid vibration of the particles of the slightly overstretched fibres; and on account of certain electrical peculiarities which it presents.

Mention should be made of the fact that a muscular contraction presents three phases—viz. the latent period, the phase of shortening and thickening, and the relaxation period, during which the muscle is returning to its original form. There is practically no change of bulk during the contraction of the mobile muscle-substance. The length of the different phases varies under various conditions. The contraction phase is the most important of the three. The causes which determine the character of the phase of relaxation have not been fully made out.

A muscle habituated to exercise can do more work, and do it better, than an unexercised muscle; and for two reasons: exercise makes the muscle larger, harder, stronger, and more enduring, improving it simply as a tool in all its structure; and, secondly, the muscle responds more quickly and completely to the stimuli which stir it up to work. In other words, the muscle becomes more obedient to its stimulators, the nerve-centres, through its better acquaintance with them. A muscle, then, is a neuro-muscular machine for developing power, for transforming the potential energy stored up in its substance and the blood brought to it into one or another form of the energy of motion.

If we consider a single muscle as a mechanism for developing energy of motion, it may be compared to a peculiarly-arranged collection of cartridges loaded with powder and connected by wires with a series of electrical batteries. Each muscle-fibre would, in that case, stand for a single cartridge, the shell of the cartridge being represented by the sarcolemma and contractile substance; the charge of powder by the unstable chemical compounds stored up or loosely held in the contractile substance; the wire from the battery by the motor nerve-fibre, and the cells of the battery by the cells of the nerve-centre; and the electric current by the nervous stimulus, which, passing along the axis-cylinder through the nerve-plate into the contractile substance, gives rise to the phenomena which signalize a muscular contraction.

When a cartridge is exploded chemical actions take place which result in the sudden formation of gas, accompanied by the development of light, heat, and sound, and the production of a residue of smoke and ashes. If the cartridge-shell be tight and tough, the motion of the molecules of the suddenly-formed gas will be communicated to its particles and the shell be shaken or moved from its position. By varying the construction and arrangement of the cartridges we may cause the liberated energy of the explosive to set projectiles in motion, to rend rocks, or to move parts of mountains. The results of chemical explosions in the muscle-cartridges are less

violent than those above noted, but they are sufficiently similar and well marked to be termed parallel to them. The potential energy of the muscle-fibres is transformed into the energy of motion through the decomposition of the chemically-unstable contents of the sarcolemma. Heat, sound, electrical changes, and mechanical motion are evolved. The mechanical arrangement of the parts of the muscle is such that the total motion of the mass of its fibres is communicated by the tendons of the muscle to the parts of the body with which it is connected. So long as the muscle-fibres are properly nourished, and not too severely stimulated, the muscle-cartridges may be said to reload and maintain themselves in a state of readinesss to go off on the receipt of stimuli from the central battery.

Muscles are more perfect power-machines than are steam-engines and rifled cannon, not only because they develop more work out of the energy stored up in the substances on which their activity depends, but also because they are distinguished from all machines of human manufacture by the fact that they are self-improving machines; that is to say, they become tougher and stronger as structures through exercise, and at the same time more capable and adaptable functionally. Growth or increase in the size, and probably the number, of its structural elements, and development, or increased facility in its functional activity, are the main effects of exercise upon a single muscle. The same is true of the muscular system as a whole. Exercise enlarges and strengthens it on the one hand, and renders it more responsive and discriminative as regards stimuli on the other The body, as a whole, is a machine in which the potential energy of organized material is transformed into the work which we see manifested in motion, animal heat, and the chemical actions involved in nutritive, secretory, and excretory processes. It is estimated that the tissue-changes of which a human adult body, weighing one hundred and forty pounds, is normally the seat involve the transformation of more than a ton of material in the course of a year. Muscular activity is one of the chief agents in promoting wholesome tissue-changes in all the bodily organs, and in determining the normal growth and development of the organism as a whole.

Broadly speaking, the skeletal muscles and the skeleton constitute the working or executive machinery of the system of federated tissues and organs which make up the body; and the most obvious results of orderly and well-regulated exercise are found, as we have seen, in the normal growth and development of the executive machinery itself. But the executive machinery of the body is ruled and governed by the nervous system. The muscular and nervous tissues have been well characterized as the "master tissues." Foster in the fifth edition of his *Textbook of Physiology* points out that the whole of the rest of the

body is engaged (1) "in so preparing the raw food, and so bringing it to the nervous and muscular tissues, that these may build it up into their own substance with the least trouble; and (2) in receiving the waste matters which arise in muscular and nervous tissues, and preparing them for rapid and easy ejection from the body."

The general effects of muscular exercise upon the master tissues have been pointed out already. The consideration of the more special effects of such exercise upon nervous tissue, "the masterful tissue," so to speak, may be deferred advantageously until we have discussed the influence of muscular exercise upon what Foster compendiously denominates "the tissues of digestion" and "the tissues of excretion," including under these heads all tissues and organs not classed as master tissues or indifferent tissues.

The muscular system has, then, two sets of servants—its purveyors and its scavengers. The former prepare and serve its food-materials, and the latter clear away the refuse matters which result from the chemical and mechanical processes by which its functional activity is signalized. The digestive and assimilative organs, and the arterial section of the organs of circulation and respiration, belong to the first class, and the venons section of the circulatory and respiratory organs, the perspiratory and urinary organs, constitute the second set. The purveyor and scavenger tissues serve each other, as well as the master tissues, it may be remarked, and are, like the muscles, controlled by the Archæus of the body, if we may so denominate the nervous system. Despite the number and efficiency of these purveyors, the muscles are obliged to work for their living, since the food supplied to them requires to be appropriated and elaborated. Living muscular substance is continually building itself up out of the protcid, fatty, and carbohydrate material, saline matters, and oxygen brought to it by the blood; that is to say, the lymph. At the same time, muscular substance is continually, by reason of its innate metabolism, forming products to be disposed of by the scavenger tissues, which naturally have most to do during muscular exercise and just after it. A resting muscle forms nitrogenous waste, such as kreatin, and gives off carbonic acid, and probably other matters, too; while in a contracting muscle there is a marked increase of waste given off, which consists chiefly of carbonic acid and sarcolactic acid, there being no marked increase of nitrogenous waste. In either case, the waste products drain away through the lymph- and venous channels, and are eliminated by the lungs, the kidneys, or the skin.

Next to the movements due to muscular action, the most direct and obvious effects of exercise are increased circulation and increased ventilation of the blood. The effect of exercise upon the processes of diges-

tion, sanguification, and excretion is an indirect one; those processes being modified, so far as muscular activity is concerned, by the changes wrought by it in the volume, distribution, or character of the general blood-stream.

The blood-stream flowing through a contracting muscle is at once increased in volume, and very soon changed in its chemical character, especially on its venous side. Its increase in volume is primarily due to the dilatation of the muscle-arteries and veins, and to the attendant quickening of the lymph-streams within it. This dilatation is a vaso-motor effect, resulting, as it is usually held, from the passage of dilator-nerve impulses, arising in the spinal cord, to the muscular coat of the muscle-arteries. Local diminution of blood-pressure is normally the result of arterial dilatation within a limited muscular area, provided the heart-beat and general blood-pressure remain unchanged. If arterial dilatation occurs within a considerable or enlarged muscular tract, a fall in the general blood-pressure may result, and the heart be called upon to quicken and strengthen its beat.

On the other hand, the qualitative changes in the blood which issues from muscles in contraction are such, when those muscles are at all numerous, as tend to make the general blood-stream in the right heart and the pulmonary circulation more venous than usual. The carbonic acid, or other waste, stimulates the respiratory centre in the medulla, and leads to an increase in the number and amplitude of the movements of respiration. The flow of blood to and through the heart and lungs causes a quickening and strengthening of the heart-beats. The same changed condition of the blood suffices to dilate the vessels of the skin and start the perspiratory mechanism into action, and thereby to dissipate the excess of heat produced in the blood by the metabolism of the contracting muscles, which are the principal sources of bodily heat. The dilatation of the cutaneous vessels likewise tends to diminish the peripheral resistance to the contraction of the left ventricle of the heart, thus reinforcing the simultaneous fall in the general blood-pressure caused by the dilatation, alluded to above, of the muscle-arteries. Exercise may therefore, through its indirect influence upon the skin, as well as by its direct vaso-dilator effect within the muscles, impose additional labor upon the heart. It is probable that a means of maintaining, or even increasing, the mean blood-pressure of the body, without appealing to the heart for extra effort, exists in the augmented constriction which takes place in the arteries within the abdominal splanchnic area during vigorous muscular labor. By this means the heart is spared redoubled labor, and the digestive organs are left at rest when they ought to rest. The fact that to fill the blood-vessels of the muscles and skin the splanchnic vessels are proportionately emptied, and *vice versâ*, is one of great practical importance, and

points to the impolicy of engaging in any but the most moderate muscular exercise while the digestive process is in full course.

The effects of muscular exercise may be summarized under the heads of extrinsic and intrinsic, and these, in turn, may be characterized as direct or indirect.

The most important direct intrinsic effects are: a greater flow of blood and absorption of oxygen and food-materials, and increased metabolism, resulting in mechanical work, the evolution of heat, and the formation of waste within the muscles. Under indirect intrinsic effects belong improved nutrition, structural enlargement, and improved function of the muscles.

The following are to be considered direct extrinsic effects of exercise: vascular dilatation, enlarged flow, and diminution of blood-pressure on the arterial side of the circulation; on the the venous side, an enlarged flow of the lymph- and blood-stream, which has a heightened temperature, and an increased amount of waste matters; an increase in the force and frequency of the heart-beats; and an increase in the number and amplitude of the respiratory movements. Perhaps the increased elimination of carbonic acid and watery vapor by the lungs, and their increased taking in of oxygen, had best be placed here. If so, the delivery of completely arterialized blood by the lungs to the left heart may be termed one of the direct effects of exercise.

The following may be classed as indirect extrinsic effects: viz. the depuration of the blood, so far as the action of the sweat-glands, the kidneys, and the liver are concerned in it; the dilatation of the cutaneous vessels, and the consequent cooling of the blood and the maintenance of the normal bodily temperature; vaso-motor changes and the variations in blood-pressure, especially in the abdominal sections of the circulation; and the promotion of the nutrition and functional ability of all the tissues, owing to the better character of the blood furnished them and to the more effective play of the organs of circulation.

All mention of the intrinsic and extrinsic effects of exercise upon the nervous system has been omitted in the foregoing summary, for the reason that those most important effects will be treated separately later on. The capital importance of the extrinsic effects of exercise upon the circulatory and respiratory mechanisms has been most forcibly put by Michael Foster. "The capacity for arduous muscular labor," he says, "is determined, not by the respiratory mechanism alone, nor by the vascular system alone, but by both, and especially by both working together in harmony and concert. The increased ventilation would be idle unless it were accompanied by a quicker circulation, and the quicker circulation would similarly be of comparatively little use unless accompanied by increased ventilation. . . . . And, as a rule,

it may perhaps be said that when two men differ in their capacity for strenuous work, such as running a race, the difference, though it is often familiarly spoken of as one of 'wind,' or power of breathing, is in reality not a difference in ventilating capacity, but a difference in the power of the heart to keep up and work in harmony with the increased respiratory movements."

If we bear in mind that next, perhaps, to an adequate supply of proper food nothing so promotes the normal growth and development of the body as well-regulated muscular activity, it is interesting to compare the children of different classes of the population as regards their height and weight. Although Dr. Bowditch, professor of physiology in the Harvard Medical School, and others in America have made valuable observations in this field, still, as more interest has been shown in this kind of investigation in England, where classes as such are more easily studied than with us, and the value of exercise, especially that derived from athletic sports, has been longer and more generally recognized, I shall cite here English observations only.

The very complete and valuable tables published by Dr. Charles Roberts of London touching the mean height and weight and annual rate of increase in the case of some 7800 boys and men, between ten and thirty years of age, belonging to the artisan class on the one hand, and 7700 males, between ten and thirty, belonging to the most favored class on the other, show that the mean height of the artisan class is, for the whole period, about three inches less than the mean height of those belonging to the most favored class. In the latter class public-school boys, military and naval cadets, university and medical students were included. Although the inferior stature of artisans may be to some extent an inherited characteristic, it is held to be chiefly due to "the continuous operation of various conditions of life which retard and arrest growth, and which are most influential when growth is most rapid." Among the conditions so operating "scanty feeding and wearing toil," as contrasted with "abundant nourishment and moderate exercise," occupy a prominent place. These tables also show a progressive gain as regards weight on the part of the favored over the industrial class, both absolutely and in relation to height throughout the entire period under review. At the age of ten years the boys of the most favored class exceed the artisans' sons by one pound in weight; at twelve their excess in weight has increased to four pounds, and at thirteen they are ten pounds ahead. At the age of twenty well-to-do English youths have a mean weight of eighteen pounds more than that of handicraftsmen of the same age living in large towns. As regards chest-girth—and well-directed exercise tells directly upon chest-capacity—the most favored class is clearly superior to the industrial, which superiority is progressively increased until nearly adult life. In

another of Dr. Roberts's tables it is shown that the sons of professional men living in the country exceed town boys of the same class by about an inch as regards height at all ages between ten and twenty, and as regards weight by an amount varying from one to seven pounds. It also appears that the sons of soldiers, policemen, messengers, and the like, are from one to four inches less in stature and from four to thirteen pounds less in weight than boys of the same age whose fathers are devoted to intellectual pursuits; that the sons of artisans and factory operatives are the shortest and lightest of all youthful Britons with the exception of idiots and imbeciles of the same age, who have a mean height of an inch less than even youths of the artisan class. American boys seem to be a little taller and a little heavier than their English cousins of the same age and class.

Dr. Boulton, another English student of anthropometry, made observations extending over ten years on a certain group of children, all of whom were healthy and the offspring of well-to-do parents. Dr. Boulton finds that "average English children brought up under favorable circumstances grow from two to three inches a year. A growth of less than two inches or more than three should excite apprehension; the former would indicate arrested development. The rate of growth should be regular, and being so prognosticates future good stature." As to weight for height, whether a child grows two, two and a half, or three inches in a year, weight for height should be in each case identically the same, and all healthy children should grow broad in proportion to their height. "Between three and four feet the increase in height should," he says, "be two pounds per inch, and between four and five feet two and a half pounds per inch. Well-nourished children, of healthy parents in favorable surroundings, generally attain these averages. But what of children that fall below the standard? I find there is a seven-pound margin of safety, and that children falling more than seven pounds below this standard are devoid of reserve of stamina on which to draw, and consequently succumb quickly to many constitutional diseases. This, then, may be called the preventive medicine margin beyond which lies the dangerous land of cachexia."

There is a condition of mind and body not infrequently seen nowadays in children and youths, especially among females, which is characterized by an irritable, easily overwrought, and unsteady nervous system, arrested muscular development, disordered digestion, and enfeebled powers of assimilation; which might well be called *cachexia scholastica*, since it is largely, and sometimes directly, brought about by ignorant and foolish parents and teachers, who force and cram and overwork the undeveloped brains of children, and at the same time, by neglecting or frowning upon their play and exercise, do their best to retard the

growth and development which they ought to promote and might regulate.

The late Alexander Maclaren's experience, with the first squad of twelve non-commissioned officers sent to him to be qualified as instructors in gymnastics in the British army may serve to show how systematized and well-directed exercise may be made to influence bodily development in a comparatively short time. The twelve men alluded to ranged between nineteen and twenty-nine years of age, and had seen from two to twelve years' service. At the end of eight months' gymnastic training the increase in the measurements of the men was as follows:

	Weight.	Chest girth.	Forearm girth.	Upper-arm girth.
The smallest gain . . .	5 lbs.	1 inch.	$\frac{1}{4}$ inch.	1 inch.
The largest gain	16 "	5 inches.	$1\frac{1}{4}$ inches.	$1\frac{3}{4}$ inches.
The average gain	10 "	$2\frac{7}{8}$ "	$\frac{3}{4}$ inch.	$1\frac{3}{4}$ "

"The muscular additions," says Maclaren, "to the arms and shoulders and the expansion of the chest were so great as to have absolutely a ludicrous and embarrassing result, for before the fourth month several of the men could not get into their uniforms, jackets, and tunics without assistance, and when they had got them on they could not get them to meet down the middle by a hand's breadth. In a month more they could not get into them at all, and new clothing had to be procured, pending the arrival of which the men had to go to and from the gymnasium in their great-coats."

Enough has been said, I think, to show that muscular exercise exerts a potent and important influence upon the growth of the body and upon the elaboration and perfecting of its more familiar systems of organs; but thus far its most important effect, that upon the nerves and brain, has only been alluded to. The nervous element involved in muscular exercise is oftener overlooked than recognized by the mass of writers on the subject. Maclaren, whose book on *Training in Theory and Practice* is one of the best of its class in the English language, defines exercise as "muscular movement" simply, and declares its object to be "the destruction and renovation of tissues." This is the ordinary view, from which one finds but little deviation in the vast majority of the textbooks on physiology, and of the books and articles on exercise, whether they have been written for school-girls or medical students.

"We seek in vain in most physiological textbooks," says Du Bois-Reymond, "for instruction respecting exercise: if it is given, only the so-called bodily exercises are generally considered, and they are represented as merely exercises of the muscular system. Therefore it is not strange that laymen in medicine, teachers of gymnastics, and school-

teachers believe this. Yet it is easy to show the error of this view, and demonstrate that such bodily exercises as gymnastics, fencing, swimming, riding, dancing, and skating are much more exercises of the central nervous system, of the brain and spinal marrow. It is true that their movements involve a certain degree of muscular power; but we can conceive of a man with muscles like those of the Farnesian Hercules who would yet be incompetent to stand or walk, to say nothing of his executing more complicated movements."

The arm of the blacksmith has been brought into play so often, by writers and talkers on exercise, that every school-boy credits the statement that muscles grow larger, harder, and stronger when duly exercised, and become weak, flabby, and wasted if they are suffered or forced to remain inactive. It is less obvious, though it can hardly be doubted, that use and disuse work similar effects in the ease of nerve-cells and fibres, both sensory and motor. Though conclusive evidence is lacking on this point, it seems probable that exercise of the muscles not only reacts upon the nerves and centres, with which they are connected, in such wise as to enhance the power and ease with which they originate and transmit motor impulses, but that it also leads to an increase in the number, size, and elaboration of their parts. That disuse of end-organs, both sensory and motor, leads to atrophy of their nervous connection has been clearly made out. Meynert quotes Mendel as saying "that nerve-tissue, like muscular tissue, increases during mental work."

The fact should never be lost sight of that a single muscle is not a simple organ, but is made up of two clearly-distinguishable though conjoined mechanisms—a contractile, executive mechanism, the muscle proper, and a stimulating, regulative mechanism, consisting of nerve-fibres and gray-matter nerve-cells. Each mechanism has its blood-vessels and lymph-capillaries for supplying food and drainage, and the amount of blood supplied to each is proportionate to its functional activity. If in life the two mechanisms become dissociated, or if either suffers from malnutrition, unregulated exercise, or structural depravity, the dual organ is thrown out of gear, and its working becomes disordered or abolished, in much the same way as when the attempt is made to split a human being into a mental part and a bodily part, and to train the dissevered fractions to functionate as entities. Muscular movement is, then, a resultant effect due to the balanced working of the conjoined mechanisms alluded to. The nervous mechanism is concerned in a somewhat higher kind of work than that of its muscular colleague, and may be said to *represent* the movements of which the latter is the seat and instrument. Between the nervous arrangement which represents the twitch of a single subcutaneous muscle inserted into the base of a hair-follicle, and that which represents and governs

the varied and rapid muscular adjustments which characterize the hand and fingers of a cunning craftsman or artist, there exists every grade of complication.

If we compare an adult man and one of the highest of the lower animals in respect to the movements of which they are capable, we find that they possess many in common, but that man is distinguished from the brute by certain movements, such as those involved in maintaining the erect posture and in the action of the hands and vocal organs, and that, corresponding to these two classes of movements, there are two classes of nervous mechanisms by means of which they are represented. These mechanisms have been well termed fundamental and accessory, respectively.

Similarly, it is demonstrable that while the human infant and adult possess many nervous mechanisms identically alike in structure and function, the adult is characterized by certain other mechanisms whose structural peculiarities, connections, and powers have been evolved and superadded as the result of growth and training. The law of evolution, as applied to the nervous system, is coming to be very generally recognized by neurologists. It is a law which educators, both mental and physical, should ponder upon and be guided by. Dr. Ross of Manchester, England, in his *Diseases of the Nervous System*, in speaking of this law, which was originally enunciated by Herbert Spencer, describes it as "a progressive integration both of structure and function, during which there is a passage from the uniform to the multiform, the simple to the complex, from the general to the special." "During the evolution of the nervous system of man," he says, "the fundamental portion is first developed. The nervous system of man is at first similar to that possessed by all animals which possess a nervous system, or, at any rate, all those which are sufficiently elevated to possess a spinal cord; but as development proceeds the nervous system of man becomes gradually differentiated from that of an ever-increasing number of the lower animals, while still maintaining a general likeness to the nervous system of the higher animals up to the time of birth. This, then, constitutes the fundamental portion of the nervous system of man; but after birth the accessory portion, which up till this time only appears in a rudimentary condition, now undergoes progressive development. It will thus be seen that the fundamental portion is first developed, and that the superaddition of the accessory portion greatly increases the multiformity, the complexity, and the specialty of the human nervous system, and that it is the latest product of its evolution."

As might be expected, the structural elements of the nervous system follow this law. The many-branched nerve-cells, having a process prolonged to form the axis-cylinder of a nerve-fibre, are the most

highly organized and special of nerve-cells, but they begin as small, round, uniform, unbranched cells. The medullated nerve-fibre, made up of axis-cylinder, sheath of white substance, and outer investing membrane, is the highest form of nerve-fibre. At the other end of the series stand the primitive nerve-fibrils, a bundle of which may be said to constitute an axis-cylinder. Among intermediate forms are axis-cylinders with no sheath whatever, axis-cylinders covered only by a sheath of white substance, and non-medullated fibres, consisting only of an axis-cylinder enclosed in a fine, thin, structureless sheath. At birth the fundamental portion of the nervous system of a human infant is characterized by the presence of branched cells and medullated fibres in contradistinction from the rudimentary accessory portion, which contains small round cells, primitive fibrils, and non-medullated fibres. Later, if all goes well, the round cells become branched and the non-medullated fibres become medullated.

Ross has much to say of the distinction, noted above, between accessory and fundamental structures and functions. "The movements of the hand," he says, "afford the best example of the accessory functions of the spinal cord. These movements are peculiar to man, and by far the greater number of them are acquired after birth. It may therefore be expected that the development of the structure which represents these movements in the spinal cord will also take place after birth. The movements which are most characteristic of the upper extremity in man are those of pronation and supination of the forearm and the complicated movements of the hand and fingers; and it is exceedingly probable that the structural representatives of some, if not all, of these movements are to be found in the median group of cells. These cells appear at a late period of the development of the cord, hence they form a specialty of structure which corresponds to some specialty of function. Again, they maintain a small size even in the adult cord, and consequently may be expected to preside over the action of small muscles, both of these conditions being realized in the hand.

"The smaller median area in the lumbar enlargement of the cord," says Ross, "presides probably over the movements of the lower limbs which distinguish the adult man from the lower animals, and also from the human infant. These movements are mainly executed by the extensors of the leg on the thigh, and probably also by the adductors and by the flexors of the foot on the leg. Indeed, the slight elevation of the ball of the toe, so as to allow the passive leg to swing forward by its own weight in walking, is the last movement acquired by the child; and we shall subsequently see that it is the first movement to be affected by disease. If, then, the median area of small cells be the structural correlative of the later-acquired and more special movements of the limbs, it must be absent in those portions of the cord which do not

supply nerves to limbs; and we have already seen that this area is absent in the dorsal and upper cervical regions of the cord."

The same author attributes the spinal-cord regulation of fundamental voluntary movements to its antero-lateral group of cells, and notes that "the cells of this group always maintain the lead in the course of development. It is not only that they begin to develop and assume processes at an earlier period than the cells of the other groups, but the greater portion, if not all, of them appear almost simultaneously, and maintain an equal rate of growth during development. It may be expected, therefore, that this group will regulate the fundamental actions or those which are carried on in a reflex manner, and which are in great measure independent of the cephalic ganglia. In this connection the intercostal muscles, the diaphragm, abdominal muscles, and the muscles constituting the floor of the pelvis will immediately suggest themselves."

There are certain areas in the gray matter of the fore-brain of man whence proceed, it is now generally held, stimuli to the most important groups of voluntary muscles. In one of these regions are the centres which control the different groups of muscles of the upper extremity; and for the sake of simplicity we may consider that the centres of the muscles which move the shoulder, elbow, wrist, and fingers lie near to and are connected with one another. The actions of the shoulder and elbow are fundamental and well organized in the infant, as compared with those of the wrist and fingers, which are accessory and later acquired. In order that the action of the different segments of the fore-limb should be properly co-ordinated as to time, force, direction, and degree, their motor centres must habitually discharge their stimuli in due sequence and degree. Experiments on young puppies show that their motor areas are not sufficiently developed until they are ten days old for them to make voluntary movements with their limbs. Ferrier declares that "the degree of development and control which a puppy reaches in ten days or a fortnight is not attained by the human infant under a year or more." The infant, through the growth and development of the appropriate accessory centres, first gains co-ordinative control over its foot and leg, then over its arm and hand, and later over tongue and lips. It is evident that the arms of a blacksmith and those of a five-year-old boy and of an infant differ greatly as regards size, strength, and skill; but the differences which exist between them reside in the nervous mechanisms which represent the movements of which their respective muscles are capable, rather than in the muscles themselves. Not only are the motor nerves of the blacksmith the largest, but the cells in the motor areas of his brain and spinal cord are also more numerous, larger, more branched, and more widely connected with other cells. Exercise plays, if not the predominant, at least a very considerable, part in producing this result. The effects of

exercise are at once seen if one compares the right and left arms of the average blacksmith with one another. It is well known that the centres which control the right hand are situated in the cortex or outer layer of gray matter of certain portions of the left fore-brain, and that those which control the left hand are in the right fore-brain. Flechsig, who has made exhaustive studies as to the course and number of the motor-fibres which connect the muscles of the two extremities with their respective main centres, is quoted as saying that the number of fibres going to the right hand is to the number of fibres going to the left hand as three to two.

The fact that cerebral action is a large factor in voluntary muscular movements has been strikingly stated by Foster. "It is clear," he says, "that, admitting the pyramidal tract to be the ordinary channel by which volitional impulses pass to, or by which the will gains access to, the motor mechanisms immediately associated with the anterior roots of this or that spinal nerve, we must also admit that those volitional impulses passing along the pyramidal tract, or at least some of the processes constituting the will, are in connection with, and thus influenced by, the condition of other parts of the brain. When, for instance, a gymnast executes a skilled voluntary movement, in which all his four limbs and other parts, as well, perhaps, of his body, are involved, it is probably the case that changes of the nature of efferent impulses sweep down his pyramidal tract, and that these impulses, starting in a definite order from his cortex—that is to say, having undergone a certain amount of initial co-ordination at their very origin—meet with further co-ordination in the spinal gray matter, which serves as a set of nuclei of origin for the motor nerves concerned in the movement, before they issue as ordinary motor impulses along the anterior roots. But this is not all. Should the gymnast's semicircular canals happen to be injured, and his cerebrum thereby be troubled, or mischief fall on some other part of the brain which like this has no direct connection with either the pyramidal tract or the motor cortex, the movement fails through lack of co-ordination, though both the cortex, the pyramidal tract, and the spinal-motor mechanism remain as they were before. Obviously, the carrying out of a voluntary movement is a very complex proceeding, and the motor cortex with the pyramidal tract is only one part of the whole mechanism : so far from the whole business being confined to these, it is perhaps no exaggeration to say that in each movement of the kind most parts of the whole brain have a greater or less share."

The mere disuse of a muscle causes it to diminish in size. The most extreme forms of muscular atrophy and paralysis are due to diseased conditions which originate in nerve-centres or nerve-fibres. Lesions in the central nervous system may cause the bones to atrophy,

as well as the muscles. The development of a group of muscles of an entire limb, or of one side of the body, may be arrested by reason of certain forms of central nervous disease which occur in infancy and childhood. Observations made upon the brains of persons born with an arm or hand lacking, taken in connection with observations made on the brains of those who have had a hand or arm amputated, go to prove that the suppression or considerable diminution of certain movements brings about a condition of atrophy or arrested development, as the case may be, in those centres which would normally represent such movements. One may attain to the stature and semblance of manhood, and yet, through the arrested development of certain of his motor centres, be nothing better than an infant or a mere animal as regards his powers of action; while paralysis and atrophy may reduce a man, stage by stage, to the condition of an untrained child or of a helpless idiot, or even to that of a living corpse.

The functional improvement of the nervous mechanism which represents any movement, whether it be simple or complicated, automatic, reflex, or voluntary, is then to be considered as the most important effect of muscular exercise. It is not altogether clear just how it comes about that through trial and repetition an action, which is at first a difficult feat, becomes a pleasurable accomplishment, then a routine performance, and at last an almost instinctive act. But there is a settled conviction, among those who know most about both healthy and diseased nerves, that the frequent or habitual passage of stimuli from a given group of cells through definite fibres to the muscles concerned in a given movement leads to some kind of rearrangement of the molecules composing the irritable protoplasm of fibres and cells, so that less and less resistance is offered to the passage of subsequent impulses from the same source. Somehow or other, the memory of past actions and the stimuli which evoked them becomes imbedded or organized in the centres of the motor areas. The principles of physical training, whatever its end and aim may be, are based upon the power of the nervous system to receive impressions and register them or their effects; or, in other words, upon its ability to memorize the part it plays in acquired movements, and on occasion to recall and revive such movements. His once too vividly impressed sensory centres cause the burnt child to dread flame; and the difficulty of interesting an old dog in new tricks, except so far as he delights to criticise and decry them, arises from the preoccupation of his centres by old impressions rather than from their increasing insusceptibility to fresh ones.

From careful studies made as to the character of the dreams of the blind it appears that the memory of visual objects is not organized until between the fifth and seventh year of life. Persons born blind do not dream of objects in the outer world, and those who become blind before

attaining their fifth year do not dream of objects seen by them before their loss of sight. They are blind-minded as well as blind-eyed as regards such objects. There are authentic cases recorded of persons whose memory of objects, seen before the access of their blindness, persisted for twenty, thirty, and even fifty years. Then the record of their visual impressions became effaced, and they ceased to dream of objects in the outer world. The case of a man born without either hands or feet is in point here. Although he had eyesight, he did not dream of executing hand or foot movements, yet he had sufficient use of his stumps to write what is termed a good hand. There was no record of hand or foot movements in the centres which ordinarily control such movements, so that he was unable to dream of movements which he had never executed. On the other hand, the instances are very numerous in which men who have lost a limb by amputation could feel their fingers or toes while awake, and dream in sleep, or when awake, of making complicated movements with their lost members. "Persons who have had an arm amputated," says Dr. S. Weir Mitchell, "are frequently able to will a movement of the hand, and apparently to execute it to a greater or less extent. A small number have entire and painless freedom as regards all parts of the hand." They must be blind-minded, indeed, who can deny in the face of such facts that muscular movements play an important part in the development of brain-power.

Mercier, an English alienist, in his *The Nervous System and the Mind*, published in 1888, devotes much space to an ingenious and suggestive discussion of the nature of bodily movements, and their relations to the structure and functions of the nervous system; his point of view being that "the only way to get at a knowledge of the intimate arrangement of nerve-centres is by a systematic study of the movements which they actuate, and which derive their character from the mode in which the centres are arranged." Mercier bases his attempt "to organize into knowledge the facts concerning the nervous system" upon the well-known doctrines of Herbert Spencer and Hughlings Jackson, with which doctrines Ross is in general accord. But Mercier makes little use of the embryological point of view, in accordance with which Ross classifies movements as fundamental or accessory. Mercier's central and peripheral movements are approximately identical respectively with the fundamental and accessory movements of Ross, central movements being those of the trunk, shoulder, or hips, and peripheral movements being those of the digits, mouth, and eyes. Among typical central movements are included those concerned in walking, riding, swimming, rowing, bicycling, and the various feats of gymnastics; while typical peripheral movements are those involved in writing, watchmaking, piano- and violin-playing, and sewing. Intermediate movements are characterized as "more central" or "more peripheral." A "more

peripheral movement" is not necessarily, though it may be, a movement of a point farther from the trunk. It always means a movement less closely associated with the great trunk system, and one involving the action of more individualized muscles. A movement means "any set of co-ordinated muscular actions." Central movements are "*tonic* in character, those of the other (class) approximately *clonic*." Central movements are represented in the cerebrum—peripheral movements in the cerebellum.

Mercier concludes that "central movements are continuous in duration, vague in limitation, few in number, the same in character, and form a general, approximate, or coarse adjustment; that progress toward the periphery brings us to movements that are more intermittent in duration, more precisely defined, more numerous, more diversified, and more specially adjusted to particular ends; and that at the eyes, the articulatory apparatus, and the digits, where we reach the extreme periphery, all these characters reach their highest degree of development."

Having called attention to the facts that the character and efficiency of movements differ according as they are associated with other movements with which they are coincident in time, or with which they are related as parts in a series, Mercier forms two other great classes of movements—viz. "those that are combined with other movements with which they are simultaneous, and those that are combined with other movements in sequence." "It is extremely significant," he adds, "that this division coincides with the other division already considered, those movements which are combined (co-ordinated) in simultaneity being mainly *central*, while those which are co-ordinated in succession are predominantly *peripheral*. . . . . Co-ordination in simultaneity affects the central movements first, and next spreads toward the periphery, and affects the most peripheral movements last and least. Co-ordination in succession involves the most peripheral parts most often and in the most prolonged and complex sequences; and when, as often happens, the succession begins centrally and spreads to the periphery, it is the most peripheral movements to which all the others are subservient and act as aids and adjustments.

"Co-ordination of movements in succession is effected in the cerebrum, and co-ordination of movements in simultaneity in the cerebellum. . . . . Spasm due to lesion of the cerebellum is in all respects the antithesis of Jacksonian epilepsy. In Jacksonian epilepsy the spasm begins at the extreme periphery, at the lips, fingers, or toes. Cerebellar spasm begins in the most central muscles. It produces, first, opisthotonos and retraction of the head. Jacksonian epilepsy spreads centripetally up the limbs of the trunk. Cerebellar spasm spreads centrifugally from the trunk down the limbs. In Jacksonian epilepsy the spasm is always clonic. It is always jerky, intermittent,

coming on in sudden paroxysms, interrupted by periods of complete absence. Cerebellar spasm is continuous (tonic).

"Thus we find that the functions of the cerebrum and cerebellum are antithetical and complementary to one another. The cerebellum represents, first and most, the most central muscles, and the intensity of representation decreases toward the periphery. The cerebrum represents, first and most, the most peripheral muscles, and the intensity of representation diminishes toward the centre. The cerebellum maintains a continuous same action; the cerebrum breaks up the continuous same action into interrupted and various movements. The cerebellum actuates co-ordinations in simultaneity; the cerebrum actuates co-ordinations in succession. The cerebellum regulates co-ordinations in space; the cerebrum regulates co-ordinations in time."

"The muscles not only," says Sir James Crichton-Browne, the eminent English alienist, "by the locomotion which they render possible enormously widen the field from which our sense-impressions are gathered, but also, by the experiences which their own activities involve, expand our mental resources a thousand-fold. An analysis of our ideas at once reveals to us that we have few that are of purely sensory origin: our ideas of form are not mere revived optical impressions, which are properly limited to color, but ocular impressions combined with ideal ocular movements. Our idea of a circle is a combination of an ideal colored outline with an ideal circular sweep of the eyeballs, or it may be of the tactile impressions coinciding with an ideal circumduction of the arm or hand, or perhaps both these factors combined. And so it is with our ideas of weight, distance, and resistance, which all involve sensory and motor factors; and to revive in memory any such ideas is to revive both the sensory and motor elements of their composition, and to repeat definitely in certain nerve-centres the processes which correspond with certain motor acts.

"Now, the centres of motor ideation require to be exercised in order that they may be properly developed, and may contribute usefully to mental processes; and hence muscular training is likely to assume a more important and precise place in our educational systems of the future than it has hitherto done.

"These facts, that cerebral centres never properly exercised do not develop, and that when once developed they are not so liable to waste on the withdrawal of their appropriate stimuli or when they are cut off from their natural activities, strongly inculcate the importance of educating every centre at its nascent period, and the danger of postponing education till the nascent period is over. A large district of the brain is made up of motor centres and is concerned in motor ideas. The growth of that district is evidently to some extent dependent on muscular exercise, and if that is withheld at the growth-period, the

development of that district is arrested. It is not only so, but that district is made up of a series of centres in relation with different groups of muscles, and each centre is dependent for its development upon the activity of its own group of muscles; and the defective exercise of any group of muscles during the growth-period of its own particular centre (the growth-periods in most of the motor centres having different starting-points) will result in the dwarfing of that centre, and a corresponding hiatus or a general weakness must exist in the whole mental fabric.

"From this we might deduce that swaddling-bands so applied at birth as to restrain all muscular movements, and kept on during infancy and childhood, would result in idiocy—a speculation to which the wretched muscular development of most idiots and imbeciles, and the fact that their mental training is most successfully begun and carried on through muscular lessons, give some countenance. We should also have to infer that in order to build up a sound and vigorous brain we must ensure free exercise to the different groups of muscles in the order of the development of their centres, and must in no degree interfere with the natural sequence of their evolution. That being so, we must necessarily ascertain what that natural sequence is which is so important a guide to education, for in our present ignorance of it we may unwittingly be doing much mischief.

"Suppose that we are encroaching on the time at which hand-centres ought to receive their most valuable education—their nascent period—and are devoting that time to the cultivation of the tongue and lip-centres, then we should be impairing the full development of the brain; for the hand-controlling centre, if not fully exercised at its nascent period, can never afterward attain to the highest cunning. But it seems that not only tongue, but hand, and foot, and eye, and arm, and every muscle of the body, must be trained in due season if education is to do what we expect of it, and result, not in headaches and imbecilities and nervousness and insanity, but in well-balanced growth of body and mind.

"The differences which we notice between man and man in deportment, gait, and expression are but the outward and visible signs of individual variations in the development of the motor-centres of the brain; and the stammerings, grimaces, twitchings, and antics which are so common and annoying alike to those who suffer and those who witness them are probably, in many instances, the effects of neglected education of some of those centres, and might have been abolished by timely drill and discipline."

It must be evident, I think, that muscular exercise deserves more attention than is usually given it, and that, when properly chosen, regulated, and guided, it not only "does a man good," as we so often

hear it said, but makes him better; at least, it may make him a better man, in many respects, than his father was, and enable him to transmit to his progeny a veritable aptitude for better thoughts and actions. Herein lies the power of the race for self-improvement and the evolution of a higher type of man upon the earth.

"The body of the accomplished man becomes," says Bagehot in his *Physics and Politics*, "by training different from what it once was, and different from that of the rude man; it is charged with stored virtue and acquired faculty, which come away from it unceasingly. . . . . The special laws of inheritance are, indeed, yet unknown. All which is clear is that there is a tendency, a probability, greater or less according to circumstances, but always considerable, that the descendants of cultivated parents will have, by born nervous organization, a greater aptitude for cultivation than the descendants of such as are not cultivated, and that this tendency augments, in some enhanced ratio, for many generations.

"I do not think that any who do not acquire this notion of a transmitted nerve-element will ever understand 'the connective tissue' of civilization. We have here the continuous force which binds age to age, which enables each to begin with some improvement on the last, if the last did itself improve, which makes each civilization not a set of detached dots, but a line of color surely enhancing shade by shade. There is, by this doctrine, a physical cause of improvement from generation to generation, and no imagination which has apprehended it can forget it; but unless you appreciate that cause in its subtle materialism, unless you see it, as it were, playing upon the nerves of men, and, agé after age, making nicer music from finer chords, you cannot comprehend the principle of inheritance either in its mystery or its power.

"These principles are quite independent of any theory as to the nature of matter or the nature of mind. They are as true upon the theory that mind acts on matter, although separate and altogether different from it, as upon the theory of Bishop Berkeley, that there is no matter, but only mind; or upon the contrary theory, that there is no mind, but only matter; or upon the yet subtler theory, now often held, that both mind and matter are different modifications of some one *tertium quid*, some hidden thing or force. All these theories admit—indeed, they are but various theories to account for the fact—that what we call matter has consequences in what we call mind, and that what we call mind produces results in what we call matter; and the doctrines I quote assume only that. Our mind, in some strange way, acts on our nerves, and our nerves store up the consequences. Somehow, the result, as a rule and commonly enough, goes down to our descendants. These primitive facts all theories admit, and all of them labor to explain."

We have seen that the effects of exercise upon a single muscle are chiefly two. On the one hand, there results a general condition which may be termed the heightened health of the neuro-muscular machine, which state of health involves the attainment and maintenance of a normal degree of size, strength, and working power in its structural parts; and on the other hand, a more complex and special effect—viz. the acquisition or organization by its neural parts of proper habits as regards the origination, transmission, and regulation of stimuli. The ends of exercise may then be characterized as the promotion of health and the acquisition of correct habits of action. The first is a hygienic end, while the second is a distinctly educational end. It matters not whether we consider a single muscle, which admits of only a single limited motion, or a group of muscles, or the communal structure we call the human body, or a class of school-children, or a regiment of soldiers: the ends of exercise in each case are the same, and can only be attained by a combination of hygienic and educational measures.

The main field of education is, then, the nervous system, and the especial province of physical training is found in its accessory portions. The principles of all forms of physical training, however various and divergent their special ends may be, are based upon the power of the nervous system to receive impressions and register them or their effects; in other words, upon its ability to memorize the part it has played in acquired movements, and on occasions to recall and revive such movements.

It is coming to be clearly recognized that the function of our public and preparatory schools and colleges is not to fit their scholars to engage as specialists in either intellectual, commercial, or industrial pursuits. The same rule holds good as to the kind, or rather degree, of physical training which should be aimed at in our schools and colleges. It is not their business to train up ball-players, carpenters, clerks, or professionals of any kind. General bodily training is the kind demanded; but training so general that it is vaguely or spasmodically or half-heartedly carried out, or, worse still, that is left to run itself in accordance with the whim or frenzy of the persons to be trained, will surely and deservedly fall short of success. Intelligence, system, organization, funds, and patience are just as imperatively required in physical training as in the training of engineers, musicians, or philologians.

The law of the evolution of the nervous system seems to me to furnish a sufficient criterion by which to estimate the worth or success of any scheme or system of physical training. Any system that does not provide first of all and continuously for the training and exercise of the central or fundamental groups of muscles will fail utterly in securing either the hygienic or the educational end of exercise; and

any system which substitutes training of the accessory neuro-muscular mechanisms for that of the fundamental ones, or which exacts undue work of undeveloped accessory centres, or attempts their training out of the proper order of their ripening, is bound to contribute more toward the promotion of brain-forcing than toward its prevention.

The most fundamental mechanisms of the trunk are those which are concerned in the movements of respiration and of circulation. They are quite fully organized at birth, but the need for their exercise ceases only with the life of the organism. The centres which represent the muscles by means of which the trunk is kept erect and balanced upon the pelvis are accessory if compared with those mentioned above, but are fundamental as compared with those which represent the muscles of locomotion. The muscles of the trunk are called into fuller and more frequent play as soon as the child ceases to go on all-fours, and it must then learn, after a fashion which may exigently demand correction or further training later on, to co-ordinate the movements of its limbs with those of its trunk. The child learns to flex its thigh upon the body, the leg upon the thigh, and to elevate the heel from the ground considerably earlier than it can raise its toes so that the foot shall swing clear of the ground and it be enabled to begin another step. What folly it would be to try to teach a toddling infant to run or jump or dance!

Similarly, the training of the hand and fingers should not only be preceded, but accompanied, by the exercise of the muscles of the forearm, arm, shoulder, and trunk. You shall not gather ripe manual cunning from a limb whose trunk attachments are undersized, untrained, or deformed. This fact points to the danger of exacting genuine manual training from young pupils, especially if it be divorced from its proper adjuvant and corrective general gymnastics. It is simply impossible to make any technical drill, such as wood-turning, penmanship, singing, piano exercises, or even the manual of arms, meet the proper ends of bodily education either for children, adolescents, or adults. Technical training, appealing as it does to the most accessory mechanisms, should be grounded on general hygienic and educational training, should not be pushed at too early a stage, and should be left, where it belongs, in the hands of special trainers.

Pastimes, out-of-door sports, and systematic gymnastics are the forms of exercise which yield the best results in the physical training of school-children and college-students. The plays of the kindergarten, the athletic sports to which British and American youth are so devoted, and the systematic gymnastics of the Swedes and Germans have all developed from one germ—from healthful play: the vital energy of this germ is found in the universal and ineradicable impulse of all healthy children to play. The children of every generation, no

matter how prim or sour or ascetic their parents may be, are always playing animals. That it is so is a most fortunate thing for the race: were it not so the victims of war, pestilence, and education, and of that voracious monster that men call business, would be vastly more numerous than they are.

In the athletic sports of young men we see the highest and fullest expression of the play instinct. The essential difference between athletics and gymnastics is one of aim. The aim of athletics, unless of the illegitimate professional sort, is pleasurable activity for the sake of recreation; that of gymnastics is discipline or training for pleasure, health, and skill. We have but to compare the aims, methods, and results of each, and to call to mind the characteristics of the nations which have affected athletics on the one hand and gymnastics on the other, to perceive that gymnastics are more highly developed and present more features of educational value. Gymnastics, as compared with athletics, are more comprehensive in their aims, more formal, elaborate, and systematic in their methods, and are productive of more solid and considerable results. Gymnastics have been most popular and general among the most highly-trained nations, such as the Greeks of old and the Germans of to-day. The most athletic and, at the same time, one of the most ill-trained of modern nations is the British. I mean simply this, that an Englishman believes, and acts upon the belief, that you come to do a thing right by doing it, and not by first learning to do it right and then doing it; whereas, the Germans leave little or nothing to the rule of thumb, not even in bodily education. German gymnastics embrace three well-marked fields or departments—viz. popular gymnastics, school gymnastics, and military gymnastics. The organization of the last two departments is maintained and controlled by the government for strictly educational purposes; while the Turn Vereine, as the popular gymnastic societies are called, are voluntary associations of a social and semi-educational, but wholly popular and patriotic, character. The fondness of the German people for gymnastics is almost as marked a national trait as is the liking of the British for athletic sports. The German system of gymnastics has been most highly developed in Prussia, where not far from a fifth of the population is undergoing systematic physical training at the present time under the combined agencies of the schools, the army, and the Turn Vereine. In Switzerland and in Norway and Sweden you will find school and military gymnastics, especially in Sweden, quite as fully developed as in Germany, and popular gymnastics not so much so.

I have no disposition to disparage athletic sports. I would that they were more general and better regulated than they are in our country. I believe that they are valuable as a means of recreation; that they conduce to bodily growth and improvement; and that their moral

effects are of value, since they call for self-subordination, public spirit, and co-operative effort, and serve to reveal the dominant characteristics and tendencies as regards the temper, disposition, and force of will of those who engage in them. But they bear so indelibly the marks of their childish origin, they are so crude and unspecialized as to their methods, as to render them inadequate for the purposes of a thorough-going and broad system of bodily education. It is well to promote them, and it is becoming increasingly necessary to regulate them, but it is unwise and short-sighted to consider them as constituting anything more than a single stage in the best bodily training.

One of the main defects of our school-training hitherto is found in the fact that lessons and tasks are set which involve the activity of the accessory parts of the nervous system before its fundamental portions have been properly built up and trained. The result of this inverted and unnatural order of teaching is seen in myriad forms of nervous disease which find expression in St. Vitus's dance, grimaces, spasms, convulsions, and other forms of disordered muscular action, as well as in the protean forms of headache, nervous exhaustion, and mental derangement so common nowadays amongst sedentary people and brain-workers. For the purpose of forestalling such results I would encourage games for boys and girls during their school-life, and would require of them compulsory attendance upon instruction in gymnastics, drawing and modelling, and in the elements of certain selected handicrafts for general educational purposes.

Dr. Ross, in his work before cited, has expressed himself so admirably with regard to the place of physical training in the education of children with neurotic tendencies that I quote his words in full:

"The children of parents who manifest a predisposition to severe nervous disease, as hysteria and epilepsy, are frequently not merely quick in their perceptive faculties, but are also often possessed of great intellectual powers, and much of their future happiness depends upon judicious mental training in youth. The children of such families ought not to be subjected to any severe mental strain during the period of bodily development, or be allowed to enter into competition with other children in the mental gymnastics which are so fashionable in our public schools. On the other hand, regular, graduated, and systematic exercise in the form of walking, riding, gymnastics, and calisthenics does a great deal of good by strengthening both the muscular and nervous system. Everything which tends to develop the muscles of the lower extremities and trunk, and indeed all muscles engaged in executing the movements common to both man and the lower animals, tends also to develop the fundamental part of the nervous system; and a good sound development of the fundamental is the first prerequisite to a well-balanced development of the accessory portion.

"The order of the development of the nervous system in the race has been from the fundamental to the accessory portions; and no one can reverse this process with impunity in that further development of the individual which constitutes education in its widest sense. Yet until a few years ago the natural order of development was reversed in the education of youth, and especially in female education, so far as this could be accomplished by human contrivance and ingenuity. The natural order of development was indeed observed so far as to allow the child to acquire the power of walking prior to that of other accomplishments, but the care of the infant had not yet been transferred to the professional trainer. No sooner, however, had what is technically called education begun than the professional trainer began to exercise the small muscles of vocalization and articulation so as to acquire the art of reading, the small muscles of the hand so as to acquire the art of writing, and in the case of young ladies the still more complicated movements necessary in running over the keyboard of a piano, while little attention was paid to the development of the larger muscles of the trunk and lower extremities, upon the full development of which the future comfort of the individual depends.

"In the education of youth in the present day the laws of development and physiology are not so openly violated and defied as they were a few years ago; but much remains to be done in this respect, and especially in the education of the children of families who manifest a neuropathic tendency. In the children of such families the greatest possible care should be taken to develop the fundamental actions, inasmuch as a sound development of these involves a stable construction of the fundamental part of the nervous system—a process which makes the latter to offer greater specific resistance to the paroxysmal discharges from the later-evolved centres of the accessory portions which underlie hysteria, epilepsy, and even many of the psychoses. The process of educating the accessory system, and especially the higher centres of that system, in young people with a neuropathic predisposition should be regular and systematic; habits of mental scrutiny and self-examination—which, unfortunately, too many religious teachers deem necessary for the welfare of the soul—ought to be discouraged. In one word, education should be made as concrete and objective as possible."

My plea is, that inasmuch as physical training enters of necessity into the training of every school-child, every apprentice, every recruit, those who undertake to train scholars or craftsmen, artists or authors, should see to it that mental training is not pursued to the neglect or detriment of bodily training; that each kind of training should be given its proper place in the compulsory curriculum of our public

schools; and that bodily training should be given in appropriately fitted places, by specially trained and well-qualified teachers, in a systematic, well-ordered, and rational way.

No comprehensive system of physical training can be considered safe or rational whose exercises are not adapted to meet the varied and varying wants and requirements of the individuals to be trained in respect to their sex, age, health, strength, mental capacity, and calling in life. The results which should be secured by such a system are briefly these: Easy and graceful carriage of the head and limbs; a broad, deep, and capacious chest in which the heart and lungs, developed to their normal size and strength, shall have free, full, and regular play; square shoulders; a straight back; fully-developed and well-rounded limbs; and the power to execute with ease, precision, and economy of force such movements as are involved in the simpler exercises of strength and skill and in ordinary gymnastic and athletic feats. Given sound organs, a well-knit, vigorous frame, ordinary intelligence and docility in a pupil, and your technical trainer will accomplish a hundred-fold more than he otherwise could, whether his business be to train up a professional fencer or ploughman, an actor or an acrobat, a singer or wood-carver, a penman or an elocutionist.

It is beyond question that the Grecian gymnastics and athletics affected chiefly the fundamental neuro-muscular mechanisms. The same is true of the martial exercises of the ancient Gauls and Teutons and of the popular sports of their descendants. Wrestling, running, leaping, casting the stone or hammer, tossing a beam or tree-trunk, hurling the spear, and cudgel and sword-play, are not only the most widespread, but also the most primitive and ancient, of European popular sports. Nor should ball-games be omitted from this category. Of popular sports in general we may say that they promote the more massive bodily virtues of strength, endurance, and speed, while dexterity, address, sleight-of-hand, finesse, quickness and accuracy of eye and hand require more specialized and complicated forms of exercise for their development. In other words, athletic sports are insufficient for the purpose of giving a complete training to the fundamental and accessory groups of muscles, and require to be supplemented by such drill as is afforded by the systematic gymnastics of the Swedes and Germans. For purely educational ends, no system of physical training has yet been devised which is equal to the Swedish school gymnastics. According to my observation, Swedish school-boys are better "set-up" and have their muscles under better control than either British or German school-boys.

The fact is worth noting that the question of improving and extending the scope and working of school gymnastics is now occupying the attention of the educational authorities of the principal nations of

Europe. It is the case in England, France, Germany, Denmark, Sweden, and Russia. In Denmark and France governmental commissions have for the last two or three years been engaged in framing new gymnastic codes. The new French code will be largely based on elaborate physiological studies made by M. Georges Demeny in the laboratory of Professor Marey, the eminent French physiologist. A summary account of some of Demeny's conclusions is found in an article "On Precision in Physical Education" in the *Popular Science Monthly* for February, 1891.

"Play-hours," says Demeny, "do not constitute a complete physical education. There is exercise in play-hours, but there is not, properly speaking, training of the movements in view of a useful effect. Each one does not get the portion of exercise to which he has a right. According to the general law, the strongest or most hardy are more benefited than the weaker ones, and the mean level does not rise. Games and sports are still what they always have been, an elegant means of amusement, an agreeable exercise, the privilege of the easy class, the pleasure of the smallest number."

Even in England, the stronghold of unhampered athleticism, the idea is gaining ground that the rightfully prized but overlauded out-of-door games have their limitations, and may be advantageously supplemented by gymnastics or "drilling lessons." As bearing on this point, the following extract from Dr. Francis Warner's lectures, delivered in the University of Cambridge, 1888–89, on "The Growth and Means of Training the Mental Faculty," is of interest:

"Drilling lessons have often been looked upon only as means of 'getting up the muscles,' and they have been used accordingly, with the result that, as in the case of athletics, the maximum of good has not always been attained, and harm has sometimes resulted. . . . . If the object of the physical exercises be to drill the nerve-centres, increasing the quickness and precision of their action, then the brain-centres should, as far as possible, be free to receive the word of command. We must get the attention of the class, and try to perfect the time of their actions, rather than to cause strong stimulation of the muscles. Leave the muscles free, have nothing in the hands when you wish mainly to deal with the nerve-centres; use no clubs or weights, and let the hands be open. Arrange your exercises so as to produce movements in some definite order; at the same time let them effect but little mechanical work; let the movements, following your word of command, be such as to exercise all the known physiological groups of muscular actions, the groups of muscles supplied by each cranial nerve—the eyes, face, tongue, head, and spine. In the limbs exercise muscles of the large parts and small parts, and movements of the separate digits in flexion and extension, as well as in lateral movements. Each group

of muscular actions, due to the energy of a brain-centre, may be brought into action by drilling.

"Some very beautiful exercises with balls have been used, which tend not only to regulate and quicken the effect of sight upon movement, but also to increase the power of accommodating vision as the eye follows the ball. I think that this subject of drilling the nerve-centres is well worthy of more serious attention than it has received."

Mechano-therapy has been, and still is, for the most part, employed in an empirical way. One branch of mechano-therapy—viz. massage—may now be said to constitute a part of rational therapeutics, since physiologists, pathologists, and clinicians have conjointly accumulated a sufficient body of facts to explain its working and effects, and to make clear the principles in accordance with which it should be resorted to or avoided as a remedial agent. Physiology, in its modern development, has thrown much light on the nature and uses of general muscular exercise, but until physiologists and clinicians shall have given at least as much attention to general exercise as they have to massage, muscular exercise must remain a part of empirical therapeutics, even though there be a considerable and increasing number of men who are capable of making rational use of it. The growing tendency of some of the wisest and most successful physicians to supplement the use of drugs by means of hygienic and dietetic measures is a hopeful one, and may ultimately lead to a recognition and determination of the rational uses of exercise in the treatment of disease. At the same time, it is idle and unprofitable to claim too much for, or to expect too much from, such procedures as bathing or exercise, since they are at best adjuvants only, and can never supersede the use of medicaments.

Speaking broadly, it is hardly possible to discriminate accurately between the hygienic and therapeutical effects of exercise; at any rate, when we have to do with certain general disorders, such as debility, anæmia, neurasthenia, hysteria, obesity, and insufficient muscular development. Exercise is as necessary as sufficient and nutritious food for growing children, in health, in order to secure normal growth of structure and normal development of function in the various tissues and organs. Similarly, adolescents and adults require a certain amount of muscular exercise to prevent their organs from dwindling in size and losing their full powers of functional activity. In such cases exercise, if not excessive or ill-timed, is to be considered a hygienic measure. In ill-nourished, weakly children, on the other hand, in convalescents recovering from acute or chronic illness, in many cases of brain-fag, in some forms of mental derangement, exercise may be employed as a general tonic or prophylactic.

Attention was called above to the opinions of Dr. Ross with regard

to the place of physical training in the education of children who inherit neurotic or insane tendencies. It may here be mentioned that the directors of several American asylums for the blind, for feeble-minded, for deaf-mutes, and the insane have introduced one or another form of physical training, not only as a means of promoting the health of those under their charge, but for the avowed purpose, as well, of awakening, strengthening, and refining the activities of the brain and sense-organs. Special teachers of gymnastics—and in some cases specially-erected gymnasia also—are to be found in the institutions named below: the Maryland Asylum for the Blind, in Baltimore; McLean Asylum for the Insane, Somerville, Mass.; Friends' Insane Asylum, Frankford, Pa.; the Seguin Physiological School for Feeble-minded Children, New York City; and Dr. Walter Channing's Asylum for the Insane, in Brookline, Mass. This list might doubtless be enlarged, as it was quite the fashion to adopt calisthenics and gymnastics in such institutions, chiefly as a hygienic means of recreation, about thirty years ago. M. Napoleon Laisne, a prominent and experienced teacher of gymnastics in Paris, proved some years ago, in one of the hospitals of that city, that gymnastic drill could be put to good use in the treatment of chorea.

The late Dr. E. Seguin of New York was an ardent advocate of muscular exercise as a factor in what he denominated physiological education. As is well known, he was among the first to show that idiots could be educated. In his work on *Idiocy*, Seguin gives a circumstantial account of the manner in which physical exercises were employed to awaken and confirm intelligence nearly forty years ago in the Institution for Idiots established under Dr. Wilbur at Syracuse, N.Y., in 1854. Seguin's views and experience may be cited here with profit, since they relate not only to the subject under consideration, but also afford concrete evidence in favor of the somewhat theoretical and schematic statements quoted above from Ross, Crichton-Browne, and Mercier.

In his "Report on Education" (second edition, 1880), Seguin, in speaking of English teachers of idiots, avers that "they do not seem to attach sufficient importance to that period of the education which corresponds in the idiot with what I will venture to call the *building mania* in the infancy of peoples. If we can make the pupil enter upon this period, and if we awaken that taste in him, he may be, through it, carried to the conception of higher combinations of parts to form a whole, besides acquiring, in various attitudes, operations, and manipulations of the *material*, the physical aptitudes comprehended in the word 'dexterity.'

"At the threshold of the school proper they do not seem to understand that filiation, and therefore that rational progression, which gives

precedence to the systematic movements of the body over drawing, of drawing over writing, of writing over reading; it is almost the reverse order that obtains, unless, as in the majority of instances, there is no order at all, either practised or suspected. . . . . At the bottom of success in all the arts and of all artisans is the precision of touch, which is a guide to our natural or mechanical instruments of execution. Since the muscles of the life of relation obey the nervous impulses, results of impressions either actual or previously recorded, the richer the store of sensory impressions the more true and effective will be the work done by the skilful play of the muscular contractions. . . . . But in that *touch* there is more than sensitive *tact:* there is also a force prompted by a muscular lever.

"Gymnastics and sports are instituted to develop this power; many schools have them; all should have a gymnasium; but, strange enough, hardly any one suspects its *raison-d'être.* To grow immense packs of muscles? No, but to develop parts of the body weakened or ill-nourished, to harmonize several organic and all the motor and local functions, to put the essential apparatus, as lungs, heart, skin, in working order, and to discipline every muscle of the life of relation to obey the dictates of the intellect from the brain, of the will from the sympathetic and spinal cord. This should supersede the gymnastics, boating, racing, etc. instituted to make muscle for the sake of muscle, producing clowns, amusing enough, colossi, achronological pachyderms, extinct knighthoods which cannot show on their blazon one noble though comical Don Quixote for a hundred greasy Sancho Panzas. The gymnastics we favor and demand is that which calls into useful activity the muscles controlled by the sentient and motor nerves—every lever which can be commanded by a refined intellect; this training to be done from the periphery to the centre, from the centre to the periphery, be it imitated or willed; to develop the primary elements of intentional personal *activity* and of objective *aggressivity,* giving a meaning to every muscular contraction." So much for Seguin's views in *Physiological Education*—expressed, be it said, by means of a somewhat antiquated terminology. His article entitled, "Psycho-physiological Training of an Idiotic Hand," in the *Archives of Medicine,* October, 1879, shows how he applied his theories. The case reported is that of a boy, eight years old, rendered idiotic by infantile convulsions. The boy had been under the training detailed by Seguin for one year:

"The hand of R—— was small, the nails short and brittle, fingers as if unfinished—no power, no skill, only automatic movements, mainly from the wrist. To make R——'s hand act on command was at first out of the question. He could not put it or the fingers in any given attitude. He could obey the movements of elevation and abduction of the arm, but not always nor with anything like precision.

"*Therefore his teacher had to begin the training of the hand from the shoulder by movements which, starting from the elevators of the arms, would involve successively the muscles of the arm and hand.* Thus, by a series of operations whose willed or obedient starting-point descended gradually from the spine, the child became capable of moving his hand and fingers by imitation, at first, and *proprio motu* for simple willed operations later. . . . . The movements commanded to R—— were those commencing nearer the spine, the trainer gradually extending the operations of the will to the groups of muscles approaching the extremities. Thus the limb in training not only became capable of a few willed movements of totality, later applicable to a great number of operations and convertible into smaller movements of the farther extremities, but the mind, being drilled to be carried over regions previously ruled by automatism alone, extended its dominions and circulated as if at home from the great centres to the most delicate groups of sensitive and contractile tissues at the periphery.

"To illustrate the difference of ability of the hand during these forms of training according to the origin of the impulse, I notice the freedom of the hand of R—— when driving nails in a board with a hammer—a movement of the arm and wrist—as against the sliding of a pin he holds with the intention of piercing holes in a paper, with but rare success—movement confined to the last phalanges of two fingers.

"Has he learned to read, write, and the sequel? No: his hand has learned to help himself, to amuse himself, to not bite itself, nor to slap his friends, though it is yet sometimes subject to its automatic agitations. His tact has been cultivated to the point of being conscious of the ordinary variations of the temperature, of water, food, etc., and of recognizing and naming (without the help of sight) about fifty things by their shape, and quite as many by their texture. His eye—after his touch—has been drilled to appreciate the typical forms in substance at first, and later painted, delineated, and hardly indicated; then to cut the same out of paper, etc."

The following year much attention was given to training R——'s eyes in correlation with his hands, and as a result of the training initiated in the education of his hand, above detailed, R—— was finally enabled to enter a school for ordinary children, and to do fairly well at his lessons.

Although systematic exercise has been accorded for many years a prominent place in the course of treatment and training of institutions for defectives in various European countries, notably Germany and Sweden, it is to an American institution, the New York State Reformatory, at Elmira, N. Y., that we owe the proof of the efficacy of physical training as a helpful means of reforming felons. In many

respects the Elmira Reformatory, founded in 1876, is perhaps the most original educational institution in America. Its inmates consist of male felons between sixteen and thirty years of age, serving their first sentence. All sentences to Elmira are indeterminate—that is to say, no prisoner may be confined for a period exceeding the maximum term of imprisonment provided by law for the crime of which he has been convicted. But it is possible for a prisoner to gain an absolute release in about eighteen months from the time of entering the reformatory, though he may have been convicted of a crime punishable under ordinary circumstances with imprisonment for a term of years. To accomplish this is no easy task, for the conditions of release, which is always on parole for six months at least in the first instance, are—that the inmate shall earn perfect marks for twelve consecutive months in "conduct," "labor," and "school;" that he must gain the confidence of the general superintendent and managers; and that previously to his release "some definite, permanent, suitable employment" shall be arranged for by his friends or the management of the reformatory. If a paroled prisoner gives satisfaction to his employer and the authorities of the reformatory during the period of his parole, he may then secure his absolute release and return to civil life without loss of citizenship. 9 is a perfect mark for a month; failure to earn a 3 in either conduct, labor, or school-work entails a new start, as no one is admitted to parole who has not twelve consecutive 9's to his credit. Of the 4550 prisoners received up to September 30, 1890, the number paroled was 2611. It is claimed that about 70 per cent. of those who have been released from the reformatory have not relapsed into crime. The average detention before parole was twenty-one months.

In June, 1886, at the suggestion of Superintendent Brockway, Dr. H. D. Wey, the physician of the reformatory, formed an "experimental class in physical culture." The class was composed of dullards who for a year or more made had no appreciable progress in their school-work, and were likewise behindhand in their labor-tasks. The object of the formation of the class was "to ascertain if physical culture, as comprised in frequent baths, massage, and daily calisthenics, would not result in a partial awakening and stimulation of dormant mental power. Increased mental activity, rather than muscular development, was to be the gauge of the success or failure of the experiment." Eleven men, ranging from nineteen to twenty-nine years of age, were subjected to the conditions spoken of above. They were released from shop-work during that period, but were carefully schooled. The course of procedure finally adopted was to give the class two hours or slightly more a day of practice in "setting-up" exercises and in a dumb-bell drill, and each man had three baths a week, followed by "bath-massage." The members of this class were not sickly, ill-

nourished specimens, nor could they be classed with those who are technically termed weak-minded: they were simply coarse, stupid, insensitive, unambitious dullards imprisoned for felony.

The five months' experiment proved a striking success. The men improved not only in physique and carriage, but also in mental power and self-control. The average marking of the class, according to the school register, was, for the five months in question, 74.16 out of a possible 100, whereas the corresponding mark, for the five months immediately prior to the beginning of the experiment, was 45.25. Comparison of the record of the class for the six months preceding the five months of physical training with its record for the six months succeeding that period shows that the improvement gained was not of a transitory character. In the first period the general average on the scale of 100 was 46, and in the second 71; while the average marks, 3 being the scale in conduct, were—$2\frac{1}{2}$ and $2\frac{1}{3}$ respectively, and in school-work $1\frac{3}{22}$ and $2\frac{9}{30}$ respectively.

Owing to the successful results obtained by Dr. Wey in the case of the experimental class, and of several subsequent classes subjected to similar treatment, the New York Legislature appropriated funds sufficient to provide the Elmira Reformatory with a suitable gymnasium and bath-house. These establishments, costing when completed about $15,000, have been in use since March 20, 1890. The two establishments are included in one building. The gymnasium hall, which is 83 by 102 feet, has a suspended running track, and is fully furnished with apparatus, including a set of Dr. Sargent's developing gymnastic machines. The bath-house contains two "hot rooms," a massage-room, and a swiming bath 16 by 45 feet. The main portion of the inmates at Elmira are not subjected to gymnastic training; they are, however, organized as a regiment, are subject to military regulations, and are regularly and strictly exercised in military drill.

"The gymnasium," says Dr. Wey in the report of the reformatory for 1890, "has come to be, for certain classes of defectives, a place of preparation for the schools of trades and letters, and *an auxiliary to the hospital.* 128 men have received treatment in the gymnasium. Of this number, 43 comprised a class in training at the time the building was completed, and the balance, 85, were subsequently selected [out of a total of 1080 inmates]. The 85 men were placed in training for the following purposes:

"1. Physical renovation and betterment, 63.

"2. Intellection, 14.

"3. Ethics, 8.

"The first class comprised boys who were received into the reformatory poorly nourished and anæmic; those reduced through personal vices and physical disturbances incident to puberty; the shop-worn

and subjects of actual lesion or disease. For the first three varieties physical training is a reconstructive measure. For the third variety, subjects of certain lesions, an improved nutrition, resulting from increased powers of assimilation and waste, operates more favorably than hospital care and chemical therapeutics. Selections have been made for functional cardiac trouble due to nervous enervation, subacute bronchitis, epilepsy, struma, incipient pulmonary disease, and cutaneous affections, as acne, seborrhœa, and ichthyosis.

"The effect upon the dullard of the bath, exercise, and dietetics quickens and widens the scope of motor and sensory functions, draws out latent energy, and establishes a degree of susceptibility to class-room influences. Thus, qualities of cerebration become reasonably certain that were possible, but not probable, during a continuance of the subject's vegetative state.

"Those selected for ethical improvement were instances of low and faulty bodily conditions operating to the detriment of order and behavior."

The Elmira gymnasium is not due to an attack of what Dr. Seguin happily styles the *building mania.* It owes its existence to a firm conviction, born of experiment and reflection, that systematic muscular exercise is capable of building up and strengthening the brain and nerves, as well as the organs of locomotion, nutrition, and excretion. It is devoutly to be desired that a tithe of the American schools and colleges that have fallen in with the present fashion of building gymnasia should profit by the example of Elmira, and order and administer their departments of physical training in accordance with sound hygienic and pedagogical principles. Not a few college presidents and boards of trust have suffered from acute attacks of what may be termed *Pruritus œdificandi,* but the instances are extremely rare in which they have shown any symptoms of *Furor pedagogicus,* so far as physical education is concerned.

Dr. Wey's assertion that the Elmira gymnasium is an efficient auxiliary to the prison hospital is worthy of careful consideration on the part of the governors of our large general hospitals. As has been mentioned, many institutions for defectives have adopted gymnastic procedures as a part of their course of treatment and training, and a considerable number of private orthopædic institutes, having more or less complete gymnasia, might be added to the list. But I have yet to learn of any large general hospital, either in this country or in Europe, which numbers among its resources a well-equipped general or medical gymnasium. It seems to me high time that those in charge of medical schools, public hospitals, and dispensaries should give serious attention to mechano-therapy in all its branches; should test the worth of the appliances and methods now in use in this field; and should adopt and

employ such of them as may stand the test of critical study and well-directed experiment.

Medical gymnastics and massage have been left so generally, especially in this country and Great Britain, in the hands of uncritical and enthusiastic laymen, or of quacks and humbugs, that mechano-therapy is not likely to receive its due meed of recognition, from the profession at large, until some few at least of those who mould medical opinion through their didactic and clinical teachings shall have determined and set forth the actual value of mechano-therapeutical procedures and their proper relations to chemical therapeutics.

It seems a misfortune, or worse, that the profession is as yet unprepared or unwilling to speak with authority on the uses and abuses of exercise. There is already a demand for rational advice in this matter, and that demand is increasing by reason of the rapid spread of ill-regulated forms of violent exercise in school and college circles, the rapid multiplication of gymnasia and athletic clubs, and the growing agitation for the introduction of physical and manual training into the public-school curriculum. While the market is wellnigh flooded with books and articles by untrained "professors" and uncritical visionaries upon "massage," "relaxing exercises," "Delsarte exercises," "rest cures," and other fragmentary and aberrant systems of physical exercise, there exists no complete and satisfactory treatise, in English, upon the nature and effects of exercise, and the laws by which it should be regulated when employed for hygienic, educational, or remedial ends. The works of Dr. Fernand Lagrange of France and Dr. Roth of London cover the ground in a partial way only. It would seem that the public must follow for the most part misleading or false guides, so long as medical teachers and writers fail to treat the subject in a thorough-going, scientific, and practical way.

Of national systems of exercise, only the Grecian and the Swedish present a distinct department of medical gymnastics. Grecian medical gymnastics are chiefly of historical interest, as modern therapeutics have been in no wise moulded by the teachings of Herodicus, Hippocrates, and Galen with regard to dietetic exercise. We need not concern ourselves here with the mechano-therapy of the Greeks and Romans, or that of the Hindoos and Chinese, as the gymnastics and massage now in vogue are essentially products of the nineteenth century, though it is possible to show that they were matters of speculation and experiment in France, Germany, and England during the second half of the last century.

Modern gymnastics have reached their highest development in Sweden and Germany, where for some scores of years they have been systematically employed for purposes of school and military training; but the Swedish *Sjukgymnastik*, or movement treatment, is as distinctly

superior for medical purposes to the German *Turnen* as it is to the school games of the English. Swedish gymnastics were first quickened and shaped through the instrumentality of Peter Henry Ling, a Swede, who was born in 1776 and died in 1839. It is said that Ling's interest in gymnastics arose from his having been cured, while a student, of a rheumatic affection in the shoulder through the practice of fencing. He began his public career in 1804 as a teacher of gymnastics and fencing at the Swedish University of Lund. Ling was unquestionably a man of genius. and became renowned not only as the founder of Swedish gymnastics, but as a linguist and poet as well. From the time of its establishment in 1813 until his death Ling was at the head of the Royal Central Gymnastic Institute at Stockholm. Ling, though an ardent student of the anatomy and physiology of his day, never had a medical degree. He seems to have been an acute observer, an indefatigable worker, and an inspiring teacher. He and his pupils succeeded in gaining a large measure of approval and patronage from the public, in spite of the indifference or hostility of the medical profession. Early in his career Ling attracted the attention of Bernadotte, whose friendship and patronage proved of great service to him and his cause.

Ling divided gymnastic movements into four main classes—viz. 1, movements serviceable in the treatment of disease or deformity, or *Sjukgymnastik;* 2, movements chiefly useful in promoting and maintaining a normal bodily development, or *Friskgymnastik;* 3, movements suited to rendering recruits in the army and navy strong, dextrous, and enduring, or *Militärgymnastik;* and 4, movements for giving outward expression to thought or motion, or *Aestetiskgymnastik.* It is a cardinal principle in all forms of the Swedish gymnastics that any given movement of the trunk or limbs has a specific effect upon the inner organs of the body, and that in medical and developing exercises only such movements should be employed as have been shown by experience to produce the effect desired. Great care in selecting movements and strict regard to the manner in which they should be performed characterize the Swedish gymnastics.

Although many of the doctrines enunciated by Ling and his successors at the Central Institute in Stockholm seem mystical and fantastic in the light of modern physiological and medical science, they are entitled to a high meed of praise for their success in proving the practical worth of methodical muscular exercise as a means to reaching certain educational, hygienic, and remedial ends.

The procedures employed by the medical gymnasts comprise active movements, which are simply voluntary movements executed by the patient without assistance; passive movements, or movements of the patient's body or of some part of it by the manipulator; and duplex

movements, in which both patient and gymnast take part. Resisted and assisted movements, of which so much is said in massage literature, belong to the so-called duplex movements. The use of passive and duplex movements is one of the most characteristic features of the Swedish-movement treatment. According to a recent law—whose provisions are not retroactive, however—only such persons as pass the examinations set by the Central Institute in Stockholm or by a duly authorized government board will be licensed to practise medical gymnastics, and unless they possess a medical degree they must associate themselves with a physician or act under the direction of one.

The Central Institute has become the most comprehensive and thorough gymnastic school in the world. Ling has had three successors, of whom two were physicians. Its present teaching staff numbers three physicians among its members, as well as several officers of the army, fencing being a favorite branch of instruction; indeed, the majority of its pupils are young officers of the army and navy. The course of study is three years, for women two, the latter being excused from the course in fencing. One must take the full course in order to be graduated as a Sjukgymnast, but may fulfil the requirements of the normal course for teachers of school or military gymnastics in two years. Anatomy, physiology, and the principles and practice of movements are the chief studies. Didactic teaching and practical exercises are combined in the instruction throughout the entire course. Some hundreds of school-children are taught gymnastics by the pupils of the institute. In the winter of 1888–89, I found from 100 to 150 patients a day treated solely by gymnastics in the clinics of the institute, the main purpose of the clinics being to afford the pupils of the last year practice in treating disease under the immediate guidance of their medical teachers.

Disease.	Men.	Women.	Total.	Condition when Discharged.			Still under Treatment.
				Well.	Impr'd.	Unimp'd.	
Constitutional	27	49	76	18	37	1	20
Of nervous system	56	30	86	3	38	17	28
Circulatory system	23	8	31	1	19	2	9
Respiratory organs	12	6	18	0	9	2	7
Digestive organs	48	11	59	10	26	3	20
Genito-urinary organs	4	3	7	0	3	2	2
Organs of locomotion	56	69	125	35	44	7	39
	226	176	402	67	176	34	125

In this country we are accustomed to consider the movement treatment as suitable for orthopædic cases chiefly. The foregoing abstract of the report of patients treated at the Central Institute in 1884 may

serve to indicate the inadequacy of our notions in this regard: The total number of patients were 402, of whom 226 were males and 176 females; 29 patients were over sixty years and 7 were under ten years old. The number of patients between twenty and forty years of age was 182. The number of diseases specified is 48, grouped as above.

Of the 125 cases classed under "Diseases of the Organs of Locomotion," only 48 were of an orthopædic nature, 25 were of myositis, 13 of muscular rheumatism, and 34 of affections of the joints.

Medical gymnastics and massage are frequently used in combination in Sweden and Norway, though the distinction between the two is nowhere more clearly recognized than in those countries. Massage is understood to consist of a few peculiar manipulations, such as stroking, kneading, friction, and striking. It is frequently practised by persons, including many physicians, who are not gymnasts. The massage movements were described and made use of by Ling among his so-called passive movements, though the term massage is French and has become general in Sweden only within the last twenty years. Still, as is easily shown, Dutch, German, and Swedish physicians have been much more influential than the Swedish gymnasts in winning recognition for massage as a special mode of treatment. The peculiar combination of massage and gymnastics, known as pelvic or Brandt massage, may be cited as a partial exception to the above statement. Major Thure Brandt of Stockholm, a Swedish gymnast of high character and good standing, has employed massage and gymnastics in the treatment of prolapsus uteri, prolapsus ani, retroversio uteri, parametritis, etc. for many years. His method has attracted much attention in Germany within the last five years. Many German gynecologists have visited Stockholm for the purpose of receiving instruction from Brandt. Despite the fact of Brandt's being a layman, his method has been used in the clinics of Schulze at Jena, Von Preuschen at Greifswald, Schauta at Prague, Breisky in Vienna, and in the Vienna Polyclinic. Brandt's book, which originally appeared in 1863, has been republished in French and German, as well as in Swedish. Roth of London published a condensed English translation of it some years since. Reibmayr's *Die Unterleibs Massage* (Vienna, 1889) contains an account of Brandt's method, and cites some twenty-five titles of books and articles relating to it or cases treated according to its principles. The Brandt massage is sufficiently rational and conservative to be worthy of study and testing of American and English, as well as Scandinavian and German, gynecologists; but it cannot safely be relegated to ordinary rubbers who work by the hour.

The ordinary medical gymnast is often termed a manual gymnast, for the reason that he employs comparatively little apparatus in his practice, while such simple appliances as he does use do not come under

the head of machinery. One of the most notable forms of the Swedish gymnastics is that known as the mechanico-medical gymnastics, or the Zander gymnastics, as it is sometimes called after its inventor, Dr. Gustaf Zander of Stockholm. In the course of the last twenty-five years Dr. Zander, whose mechanical genius is of a high order, has devised fifty-eight different machines by means of which it is possible to give circumscribed and accurately regulated exercise to almost any particular group of muscles in the body. The principles and aims of the mechanical and manual gymnastics are essentially the same; but it is claimed that the former is a cheaper, more accurate, and efficacious means of procedure than the latter. In a proportion of cases the claim is doubtless just, but it is often necessary to supplement the use of the machines by the employment of a trained hand, especially in affections of the joints. The Zander system has been uncritically described and decried in some quarters as a system of mechanical massage. It is nothing of the kind. Dr. Zander distinctly disclaims having attempted to devise such a system, and has a staff of trained masseurs to give massage in cases properly calling for it. What he does claim is this: that the most important and valuable of the procedures comprised in the movement treatment can be better given by his machines than by manual means.

In the construction of his machines Dr. Zander has made use chiefly of the mechanical principle of the lever, as that is the principle of construction in most of the joints of the human body. By the ingenious use of counter-weights, and of perforated weights which may be fastened at any desired point on the arms of the lever, the resistance afforded by the machines can be accurately adjusted to the special needs of individual patients. The machines are divided into two main groups—viz. those set in motion by the muscular effort of the patient, and those run by a motor. For the latter series an engine of from six to ten horse-power is sufficient. The first group of machines are termed machines for active movements, and comprise the following series of machines: twelve for arm movements, such as flexion, extension, and twisting at the shoulder, elbow, and wrist; thirteen for similar leg movements; nine for trunk extension, flexions, and twistings; and three for trunk-balancing movements. In the second group are five machines for passive movements and thirteen for mechanical manipulations, such as shaking, chopping, rubbing, and kneading. Besides these, Dr. Zander has designed five machines for the special treatment of scoliosis, of which three are employed to counteract abnormal curvature and rotation of the spinal column by means of carefully regulated pressure, and two are used for accurate measurement of the back and thorax. For distinctly medical purposes the machines for passive movements and for mechanical manipulations are rather more service-

able than the active movement machines, which are more particularly intended for dietetic or developing gymnastics.

As is well known, Dr. Sargent of the Hemenway Gymnasium at Harvard University, has invented a series of some fifty so-called developing gymnastic machines. In the Sargent machines, which are now to be found in most of the newer gymnasiums of the United States, adjustable pulley-weights, running between metal rods as guides, are employed in a great variety of ways. Only active movements are provided for in the Sargent system, which is much better adapted to secure dietetic than medical ends. Although the Zander machines are superior in many respects to the Sargent machines, their cost is so great that their use is not likely to become general in our ordinary gymnasium. The Woman's College of Baltimore, however, has fitted its gymnasium with a nearly complete set of Zander machines for active movements, being the first institution in the United States to import them. There has been, however, for some years a complete Zander institute in Buenos Ayres, in South America. The only complete set of Zander machines in the United States is found in the Medico-Gymnastic Institute of Dr. L. Wischnewetsky in New York City, which was opened in the autumn of 1890. A full set of the machines has been purchased, however, for a projected Zander institute in Boston.

The Zander Institute and its founder stand deservedly high in the estimation of the medical profession of Stockholm, where the physicians are more inclined toward mechano-therapy than ever before. The institute was opened in 1865, and has since been in continuous operation. It is, however, open for patients only from September 20th till May 15th. It has no boarding-house, hospital, or hotel attachment. In the year 1888–89, Dr. Zander's patients numbered 619; in 1887–88, 549. The following statistical statement will afford an idea of the scope of the treatment. Patients were treated in 1887–88 as follows:

For anæmia and chlorosis	27
For obesity	13
For nervous affections	79
For heart affections	108
For diseases of the lungs	11
For diseases of the digestive organs	89
For diseases of the organs of locomotion	159
Number taking dietetic gymnastics	63
	549

The success of the Swedish gymnasts, both by manual and mechanical means, in treating affections of the heart has been quite remarkable. In this branch of treatment the Swedes certainly anticipated the so-called Oertel cure for weak and fatty heart. It is so totally foreign to our ideas to prescribe or even allow gymnastics in cases of heart disease

that a closer analysis of those cases included in the above table will be of interest. Of 108 cases under heart affection, there were—

2 of angina pectoris,
27 of erethismus cordis,
52 of asthenia cordis,
20 of vitium organicum cordis,
7 of endarteritis chronica.

Dr. Zander has had marked success in treating scoliosis. He has devised an ingenious apparatus for measuring the deviations of the spinal column, and makes constant use of it in checking the results of his treatment. (For an account of Dr. Zander's methods and results see his article, "Om Den Habituela Skolioseus Behandling Medels Mekanisk Gymnastik," in *Nordiskt Mediciniskt Arkiv*, Band xxi., Nov. 22, 1889. The article is in Swedish, but is accompanied by an abstract in French.)

There are two Zander institutes in Stockholm, and one institute where a partial set of the Zander machines are employed in combination with manual gymnastics. At the Royal Central Institute and at the Orthopædic Gymnastic Institute, which has been subsidized by the Crown for many years—perhaps thirty or more—the Zander machines are not in use. Several smaller institutes belonging to private gymnasts also exist in Stockholm. It is within the mark to estimate the number of patients who are annually treated according to the principles of the movement treatment in the city of Stockholm as from 1500 to 2000; this does not include those in hospital or private practice who receive an exclusive or preponderant massage treatment. Zander institutes are also found in Upsala, Gothenburg, Norrköping, and Orebro in Sweden; in Christiana in Norway; and in Copenhagen, Denmark.

Outside of Scandinavia mechano-therapy has won recognition chiefly in Germany. This is especially true of the Zander system of gymnastics. In 1885 there were Zander institutes in St. Petersburg, Christiana, Helsingfors, and London; the only one in Germany was at Baden-Baden. Now there are Zander institutes in Berlin, Hamburg, Breslau, Wiesbaden, Frankfort, Munich, Dresden, Karlsruhe, Würzburg, Mannheim, Vienna, and Budapest. It is Dr. Zander's rule not to sell his machines to laymen. The textbook on this subject is one entitled *The Movement Treatment and Massage, with Especial Regard to the Zander System of Medical Gymnastics*, Wiesbaden, 1889. It was written by Dr. H. Nebel, formerly medical director of the Zander Institute at Hamburg, now of the Zander Institute at Frankfort. Dr. Nebel's book is of especial interest, for the reason that he reports on the major part of nearly 1500 cases treated by him in the course of two seasons at the Hamburg Institute. The report of Dr. Heiligenthal, medical director of the Grand Ducal Frederick's Bath at Baden-Baden, is worth noting. The report was published in March, 1888. The

department for mechanical health gymnastics was opened in June, 1884, with some 20 of the Zander machines. In the course of two years it was found necessary to increase their number to 73. In 1884 the number of persons who used this department of the Frederick's Bath was 115; in 1885 it was 269, and in 1887, 633. The cases treated in 1887 were classed as follows: Diseases of the nervous system, 140 (therein were included 34 cases of diseased sensory nerves, 31 of disease of motor nerves, 8 cases of writers' cramp, and 42 cases of neurasthenia); diseases of the heart and blood-vessels, 84, including 30 cases of fatty heart, 23 cases of valvular disease (13 cases of mitral insufficiency, 6 cases of insufficiency of the aortic valves), 3 cases of aneurism of the aorta, 3 cases of heart neurosis, 5 of angina pectoris, 3 of arterio-sclerosis, and 1 of varix; of chronic rheumatism there were 72 cases; of lumbago, gout, and arthritis deformans, 56 cases; of obesity, 54 cases; of general debility, 44 cases; of chronic constipation, 30 cases; and others of less interest.

Enough has been said, I think, to indicate that medical gymnastics have entered on a new stage of development—that they are more carefully studied, better understood, and more generally prescribed by medical men in Scandinavia and Germany than ever before. The average practitioner of medicine has neither time nor appliances to devote to the mechanico-therapeutical treatment of the obstinately chronic cases in which he is inclined to prescribe "muscular exercise," "out-of-door life," and other equally vague remedies. Zander institutes, under the guidance and control of regularly educated specialists, would be a help and not a hindrance to the average practitioner in all our large cities. The Zander Institute in Berlin was established by an association of physicians, and the best men of the profession send patients to it.

CLIMATE.

By S. EDWIN SOLLY, M. R. C. S., L. S. A.

The object of the following article is to discuss the treatment of disease by climate, and not to give an exhaustive treatise on climatology, with a description of the several noted resorts and the diseases suitable for treatment in each; but rather to show the fundamental principles of the subject and the general bearing of admitted facts, which, if digested carefully beforehand or referred to when needed, will give to the general practitioner a rational basis for forming a judgment as to the kind of climate best suited to the patient upon whom he wishes to try the experiment of climatic change. The physician can then select from among the various places whose general characteristics range them in the class suitable for the case the one that from the more special information given in the handbooks appears to fulfil best the required conditions. Although it is desirable in a practical article on climatotherapy to avoid abstract questions and theories, it is nevertheless necessary, in order to reach the practical point sought for, to build up a pyramid as it were, the base being formed of physics, the next tier of physiology, upon which should be placed a layer of geographical pathology; then the main divisions of climates; above this their special divisions; upon this, again, a general description of the pathological conditions for the relief of which climatic treatment may be required—then the general therapeutical application; then the consideration of idiosyncrasy; and lastly, as its apex, the physician places his study of his individual case, and thus the practical point is rationally arrived at. As much of what is said under these various heads is familiar to many, each will be designated, so that when known they can be omitted in the reading and the conclusions earlier reached.

Climatology is the study of the characteristics of different portions of the earth's surface and of the effects of these characteristics upon man.

The word "climate" implies the physical characteristics of a given locality.

PHYSICS.

The elements which in their various modifying relations and proportions to one another constitute a climate are five—viz. Earth, Air, Water, Sunlight, and Electricity.

For the sake of better studying the fundamental causes of the varied peculiarities and effects of climate, certain subdivisions of the five elements are presented; but it must be borne in mind that in nature they are so closely interlaced one with the other that many of the divisions made, though convenient, are more or less arbitrary.

The first climatic element of the five enumerated is earth. This admits of two chief subdivisions—viz. composition and configuration, its composition ranging under two subdivisions—viz. soil and vegetation, and these being again divided as shown below:

Earth.

Composition.—
- Soil
  - Rock,
  - Garden soil,
  - Clay,
  - Sand and gravel.
- Vegetation
  - Trees,
  - Grass,
  - Plants.

Configuration.—
- Plains,
- Mountains,
- Valleys.

Air.

Composition.—Nitrogen and oxygen, loosely combined, accompanied by watery vapor, ozone, electricity, carbonic acid, and more or less of germs, other gases, dust, etc.

Position.—Latitude—that is, distance from the equator (temperature decreasing and barometric pressure increasing from the equator to the poles).

Altitude.—Height above sea-level (barometric pressure decreasing whilst rising from the sea-level).

Distance from the Ocean.—Giving divisions into—
- Sea air
  - Ocean air,
  - Shore air,
  - Island air.
- Inland air
  - Plain air,
  - Mountain air,
  - Valley air.

Mobility.—
- Wind,
- Calm.

Water.

Composition.—Hydrogen and oxygen chemically combined, accompanied by more or less salts and frequently vegetable and animal impurities.

Localized Water.—As in seas, lakes, streams, and springs.

Mobilized Water.—As in rain, snow, hail, and dew.

Vaporized Water.—As in clouds, mists, fogs, and the watery vapor of the atmosphere.

Water in Saturation.—As present in solid bodies, soils, rocks, and vegetation.

Sunlight, including Heat.

Light.—
- Daylight
  - Sunlight,
  - Shade.
- Night
  - Darkness,
  - Moon- and star-light.

Temperature.—
- Heat,
- Cold.

Electricity.

Constant.—
- Negative on the earth's surface,
- Positive in atmosphere.

Inconstant.—
- Thunder-storms,
- Electric disturbances.

The Earth.

Composition.—*Soil.*—The temperature and humidity of the stratum of air lying immediately over it is modified by the intrinsic qualities of the soil. These qualities vary greatly. Dry clay can absorb its own weight of water, dry garden soil about half, and dry sand about a third. Sand dries most quickly, garden soil less so, but more quickly than clay. Sand is most readily heated, but cools equally fast. The temperature of the soil is usually about the same as that of the air above it. One soil will absorb moisture more rapidly than another, and evaporate more quickly, so that the air of a locality is much affected by the nature of the soil.

The humidity of the soil has a marked effect upon the prevalence of certain diseases, notably phthisis and rheumatism, and this is why a situation over a sandy or gravelly soil is preferable for residence. The humidity of the soil, when accompanied by slow decomposition of vegetation, is the cause of so-called telluric fevers, of which ague or malarial fever is the type. When inquiries are made concerning a health-resort

the nature of the soil is not sufficiently inquired into, though it is most important, as the same rainfall or snowfall upon a clay or sandy soil has a very different effect in the two instances. On clay it is retained at the time, and then given back to the air above it; but on sand or gravel it sipes through or runs off.

Vegetation has a considerable modifying influence upon climate, for where the vegetation is luxuriant there is an increased humidity of the air and soil; and this without necessarily greater precipitation, as notably in parts of Southern California, where the rainfall is moderate, but the actual humidity considerable, the vegetation and the soil absorbing moisture from the air, and then giving it off. The nature of the vegetation has much to do with this; the trees especially so, for if they are numerous, as in forests, the damp air is held by the shade which prevents the sunlight dissipating it in vapor. The deciduous trees give off and require more moisture, and thus increase the humidity far more than the evergreens, which grow mostly on a light soil and thrive with less moisture. Evergreens are thought also to be beneficial from their exhalations of antiseptic resinous vapors. Arable land with growing crops is usually more humid than meadow-land, and it is believed that the increased growing of crops brings increased rainfall, though this is not established.

Configuration.—Plains are exposed to uninterrupted sweeps of the wind, as seen in the cyclones and blizzards which prevail on the prairies of the Western States. When wide plains are dry they are heated and cooled equally, and when no side wind blows the cooled layer of air remains upon the ground, and therefore the difference between day and night is very marked. When the plains are free from vegetation and at a considerable distance from the sea, and at an altitude, they have the qualities of dryness and sunshine and purity of air which makes such plains as lie to the east of the Rocky Mountains, and in Asia such as the "Steppes of Tartary," excellent climates for the consumptive, who, however, must have shelter, as well as vitality enough to stand the occasional severe storms which rage there.

Where plains approach the mountains, owing to the proximity of the latter there are certain modifying protections from storms.

"In all mountainous countries there is a fixed cloud-region where a portion of the moisture rising from below is condensed during the summer months. This layer of cloud, by diminishing sunshine and radiation, lessens extremes. The formation of clouds which arise from damp winds is different; the former blow along the slopes, but the latter rise and cover the peaks. The air is cooled by these winds by its coming into a colder region and by its expansion from the diminution of pressure, and being cooled it precipitates most of its moisture in the form of rain, snow, or mist, and the wind that reaches the summit

falls on the other side of the chain in a variously oblique direction, and not directly down the slope; it condenses on the way, becoming warmer in descending, in the same way as it had become cooler in rising; also it becomes relatively drier, because warm air can hold more moisture. For this reason the lee side of the mountains is drier and more extreme in climate. Mountains often give a shelter from wind by diverting it, and may also diminish sunshine and give rise to other local conditions."[1]

"The climate of valleys varies very much with the way in which they are sheltered from cold and damp winds and are open toward the sun; the sides during sunshine increase the heat by radiation, and also diminish it at night. Therefore the extremes between day and night are more marked, while those between summer and winter days are not. The question of how much the sides cut short the hours of sunshine is important. These extremes of temperature when humidity is present give rise to mists and fogs in the valleys, while the upper slope may be in sunshine.

"*Aspect*—that is, the position toward the sun and wind—makes a great difference to a place, whether it lies on the sunny or shady side of a range, the sunny side in the northern hemisphere being the slope looking to the south-east or south-west. Besides the influence of the mountains upon winds as described, there is also a considerable effect from winds blowing over glaciers and snow-fields, bringing cold and, when melting, dampness."

The Air.

The air is certainly the most important element of climate, being the chief supporter of life and carrying with it most of the other elements.

Purity.—Angus Smith writes, very truly, that we are much more particular about a change in the water we drink than in the air, although we take in a far greater quantity of air than we do water. Moreover, the modification and filtration of water by cooking, by food, and by the digestive secretions are much greater than the changes produced in the air by its passage through the respiratory tract, even in health; and these are at best imperfect guards.

Oxygen and Carbonic Acid.—The amount of oxygen relatively varies but slightly in a given weight of air, being only a matter of decimals. However, when we consider the large quantity of air taken

[1] "Klimatotherapie," von Dr. Hermann Weber, *Handbuch der Allegemeinen Therapie*, Leipzig, verlag von F. C. W. Vogel, 1880. This able and comprehensive work is the best treatise written upon climate, and I have availed myself largely of the information therein contained, and for the most part followed Weber's plan of classification of the various branches of the subject.

in during respiration, and that when the oxygen is deficient the amount is made up by some other gas, nominally carbonic acid, even a slightly lessened quantity of oxygen is often a serious matter. The oxygen is in excess, while the carbonic acid is less, where the locality is open, as on uncultivated plains and mountains, whilst, on the other hand, in towns during wet (and especially during foggy) weather there is a marked increase of carbonic acid. The absorption of carbonic acid in large amounts is undoubtedly deleterious, but, as Dr. Weber remarks, in remaining for some time in a salt vapor-bath, which contains more than 3 per cent. of the gas, no discomfort is felt, whereas in crowded rooms, which contain only 1 per cent., nausea and headache are soon experienced; it is probable that other conditions, which the decomposition of animal matter gives rise to, besides the formation of carbonic acid, are chiefly answerable for the symptoms of poisoning.

Ozone.—So far, little is known about this. Most chemists regard it as allotropic oxygen, containing three atoms of oxygen. The following points, however, may be considered as fairly established: That it is a powerful disinfectant, more so than ordinary oxygen, though as 1 part of ozone in 700,000 of atmospheric air is about as much as is ever found, its direct action through the atmosphere must be insignificant. Ozone, however, is absent where injurious decomposition is going on, as in sick-chambers, and is least in towns and greatest on the sea and mountains and under pine woods. The value of its presence would appear rather to be as evidence of the atmospheric purity than as a disinfectant. It is increased by thunder-storms and intense sunlight.

Dust, Germs, and other Foreign Bodies.—One of the chief reasons for the climatic benefits of sea- and mountain-air is the absence of poisonous or irritating substances floating on it.

Position.—The atmosphere of a locality is largely influenced by its distance from the equator—in short, by its latitude.

Latitude.—The weight of the atmosphere at sea-level is equal to a column of mercury 760 to 761 mm. in height. The column of mercury is specially low near the equator, being about 75 mm., because of the expansion of the air by heat, the lighter air rising and flowing away in the upper regions toward the poles. Leaving the equator, the pressure rises until it is highest between latitudes 30° and 40°, being there about 763 mm. to 764 mm. This appears to be caused by the currents flowing to and from the equator and the poles lying over one another. Farther toward the poles the pressure diminishes again, and is lowest between 60° and 70° north latitude.

Altitude.—The pressure continuously diminishes with the height, because the column of air above an elevated place weighs less than that at the level of the sea. The lower layers of air are much heavier than the higher, so that the air at sea-level is 1.6 times as dense as that at

Potosi, which is 13,000 feet above it. In the same locality the variations are partly periodical and partly unperiodical or accidental.

Distance from the Ocean.—Starting from the ocean itself and gradually going inland till we reach the centre of a continent, we find modifications of climate occurring which are dependent chiefly upon two main causes—the lessened humidity, owing to the distance from the evaporation from the ocean, and lessened density of the air, owing to the rise in the height of the land.

There are of course modifying local causes, as where great lakes or inland seas intervene, or the land, instead of following the general tendency toward elevation, is depressed. The especial qualities of the different airs will be discussed later.

Mobility.—*Currents and Winds*—their causes have already been explained. On the sea-coasts the usual daily sea and land breezes are accounted for in this manner: During the day the layers of air immediately covering the land become hotter than those over the sea. They rise into the upper air and flow away, and the heavier and colder layer over the sea comes in to take their place, thus producing the sea breeze, which is usually at its height in the early afternoon. After sunset, the radiation from the earth being greater than that from the sea, the layer of air over the land becomes heavier, and the sea layer, being lighter, flows away, and the breeze blows off the land to fill the void it tends to make.

Mountain and Valley Winds.—During the day the soil and lower walls of the valleys are strongly heated; consequently, the lowest layers of air in the valleys begin to rise along the mountain-slopes, radiating more rapidly than the bottom and sides of the valleys; the cold air descends with more or less force as the evening wind. For this reason places on the mountain-sides are often warmer in the evening and night than those lower in the valley. This consideration is often of consequence as regards the value of a particular valley as a health-resort, and further with respect to special houses or hotels in it. When there is a heavy rain- or snowfall or melting snows, these breezes, being damp, are apt to detract seriously from the otherwise good qualities of the resort. Dr. Weber writes as follows: "The winds are an important element in climatology, since they often quickly change the temperature, humidity, and pressure of the atmosphere, and in a way carry the climate of one place to another more or less distant; they have a great influence upon the purity of the air. It is not only the name, east, west, or north, which is to be looked to, but the character which winds from particular directions have at particular times of the year. One must therefore know how frequently winds of a certain nature blow in a given health-resort, how it is exposed or sheltered from them, or in what way they are modified by the configuration of

the neighborhood. They withdraw more or less heat from the body and evaporate more or less moisture from the surface, according to their temperature and humidity and their speed, which varies between 1 and 120 feet per second. Strong and cold winds are dangerous to patients with lung disease and to the rheumatic and gouty, while moderate currents are beneficial, especially in warm weather. They act in a more or less powerful manner, give the climate a stimulating character, taking the strength of the accommodation of the organism into account, and keep it exercised; but they demand a certain degree of strength of resistance."

Water.

Composition.—No water present in nature is absolutely pure, all containing more or less of salts, from the dense water of Salt Lake to rain-water, which is the nearest approach to distilled water that nature provides us with. Animal life is also more or less present, and vegetable and animal impurities are common.

Localized Water.—Seas, lakes, and rivers, all have modifying influences on the climate, always increasing the humidity of the air, and generally the rainfall, and in the case of seas, large lakes, and wide rivers providing over their surfaces large spaces of fresh, uncontaminated air, and giving rise to daily breezes from and toward the water, owing to the difference in the radiation of heat between the land and water. These peculiarities are experienced more upon the surface of the ocean, lake, or river than upon the shore.

Mobilized Water.—The watery vapor always present in a greater or less amount in the atmosphere is spoken of as the humidity of the air; this is of two kinds, absolute and relative.

Humidity.

Absolute Humidity is the absolute number of grains of vapor in a given quantity of air.

Relative Humidity is the amount contained by the air relative to what it could contain, the standard maximum being 100 per cent. The lowest relative humidity, according to Humboldt, is 25 per cent.; under 55 per cent. is called very dry; under 75 moderate, to under 85 moderately damp; over which, very damp. Relative humidity is only valuable when the temperature is taken with it, as warm air takes up more vapor than cold.

Clouds have an important influence upon invalids, depriving them of the advantage of the sun.

Rainfall is not synonymous with humidity, as very often the rainfall is very slight, yet the air is quite humid, as in Southern California, for example; for if there are no cold currents the vapor in the air will

not be precipitated in the form of rain. The Swiss hygrometric observations show that precipitation increases with elevation, with exceptions, as in the valley of the Engadine, where the mountains give shelter from the north and west. But in North America, as a rule, the reverse is true. The general rule is that the rainfall diminishes with increased distance from the sea-coast. The amount of rainfall and number of rainy days by no means necessarily agree, as in some places, where the rain is never moderate, there may fall in a few days more rain than is made up by a number of rainy days elsewhere. This point is of special importance as determining the number of days of outdoor life for the invalid. Speaking broadly, the number of rainy days increases from the tropics to the poles, while the amount of rainfall diminishes. With elevation up to a certain height the number of rainy days increase, above which they decrease. Rain is not necessarily prejudicial to invalids; if not so frequent or excessive as to prevent a proper amount of exercise in open air, it has the advantage of purifying the atmosphere, besides making it perhaps more vivifying by the formation of ozone and lessening of relative humidity, as people usually feel fresher and more active both during and after rain.

Snow.—The line of perpetual snow is lower going toward the poles, lower on the northern slopes of the mountains, and lower where the air is damp. Snow is not necessarily prejudicial to weak invalids, but frequent melting is of course bad. Covering of the ground with snow is often attended with advantage, as it prevents the formation of spores; snow on a clay soil, however, is always bad for invalids.

Evaporation.—The evaporative power of the air of a place is important; it is variable, depending upon the temperature, relative humidity, density, and rate of motion of the air. It is greater when the air is warm and dry, and is increased by wind; it is small when the air is still and near the point of saturation. It is most powerful in the summer, in the sun and wind, and only slight in winter, in shade, and when the air is calm. It is most active at midday, and is almost absent during continued rain or clouds or calm. It is by this evaporative power or thirstiness that the air is kept continually supplied with moisture, which is essential to organic life on the earth's surface. This humidity in the atmosphere, in checking the radiation from the earth by absorbing the heat, and also by partly arresting the direct rays of the sun, and thus regulating the light and heat, is a most powerful moderator of climate. It is the medium for the formation of dew, rain, and snow, and is closely connected with ozone and electricity. The difference between sun and shade and day and night is very great in dry climates and seasons; on the other hand, the rays of the sun may be obscured for days and weeks by too much moisture,

and the climate become depressing, both physically and mentally. This question of moisture, is, on the whole, the most important factor in considering the therapeutic action of a given climate.

Sun.

Light.—The direct action of light, apart from heat, is difficult of investigation: however, the experiments of Downes and Blunt show that light hinders the development of bacteria and other low organisms, though Tyndall's communication to the Royal Society in 1878 gave evidence of this not being constant under light alone. Moleschott's experiments on frogs show that light increases oxidation. Sunlight is more intense, of course, in dry air, and more prolonged in high latitudes in the summer, and *vice versâ* in the winter; and this point has to be considered in regard to mountain-valleys. Dr. Weber's clinical observations show that a want of sunlight produces the following symptoms: Depression of spirits, lack of energy and loss of appetite, disturbance of digestion, turbid urine, and a kind of homesickness; he also has found an irregular type of intermittent fever occurring in servants and others who sleep or pass much time in rooms half under ground, where no ordinary malarial causes are present. In one case enlargement of the spleen took place. These cases are best treated by large doses of quinine, and relapses prevented by enlarging the windows. My own experience in London leads me to believe that Dr. Weber's explanation of these symptoms is correct.

Temperature.—General Causes of Heat.—The cause of the warmth of the atmosphere and the earth's surface is mainly the sun, which raises the temperature—

(*a*) By its direct heat or radiation;

(*b*) By indirect radiation, chiefly through the reflection from the earth;

(*c*) By conduction from the earth;

(*d*) By currents.

(*a*) Direct radiation conveys but little warmth, since the air is diathermanous to the sun's rays, letting them through it, and it is only by means of aqueous vapor that they part with any heat on the way, so that the damper the air the more it is heated by the sun.

(*b*) Indirect radiation or reflection, which is chiefly reflection from the earth's surface, is influenced by the nature of the solid and liquid surfaces; most of this heat is reflected back at once; the rest is retained for a longer or shorter time on the ground; then all, or at least a greater part, is radiated back into the atmosphere.

(*c*) The earth gives up a portion of the warmth which it has taken

up to the layer of air in immediate contact, which rises and is replaced by a heavier and cooler layer, which in its turn rises and gives place to another, and so on, and thus a large amount of air is warmed.

(*d*) Currents are the most important events in the aërial ocean, by which changes called into existence at one place are carried to distant spots. The heating of a layer of air by conduction and radiation causes it to rise, and the cold air comes in to take its place, giving rise to a current which when marked is called a wind ; by these currents heated air is carried from the equator to the poles.

Cold.—To counteract the heating process first named there are constant cooling influences at work :

(*a*) Continual radiation of heat into space, where the temperature is very low ;

(*b*) A fluctuating amount of heat rendered latent by evaporation from the ground, waters, and plants :

(*c*) When the earth, which radiates heat more quickly than the air, becomes cooler than the atmosphere, the latter gives up heat by radiation as well as by direct conduction.

The chief local causes that lessen the temperature of a climate are elevation above sea-level, neighborhood of an east coast, high ranges, shutting off warm winds, wide seas between it and the equator, or absence of open water toward the poles, cloudy summers and a clear sky in winter, and cold currents, such as the one which comes down the east coast of North America from the Arctic regions.

Heat.—Local Causes of Heat.—If the earth's surface was uniform in shape and quality, and the amount of aqueous vapor in the atmosphere everywhere the same, one could accurately calculate the temperature of a climate by its latitude—that is, its distance from the equator ; but the qualifying influences of mountains, valleys, vegetation, soil, and waters make this impossible, so that in a general way only can it be said that heat decreases with distance from the tropics. The difference between summer and winter also increases at the same time, because the sun's rays grow less perpendicular and the hours of sunlight shorter as the distance from the equator grows greater. The causes of increase of climatic temperature are numerous, as by the Gulf Stream or other warm-water currents, or warm-air currents, as caused by winds from over warm seas or deserts, shelter from cold winds by chains of mountains, the neighborhood of a west coast, and similar causes.

The Mean Annual Temperature "is of less importance to the physician than that of the various seasons, as the most different climates may have the same annual mean." It is further of "great importance to know the single temperatures during certain hours of single days, as it is only in this way that the physician can determine

the average number of hours available for outdoor exercise by invalids" (*Weber*).

Electricity.

The atmosphere is charged with positive, the earth with negative, electricity. Becquerel and Breschet have demonstrated that at altitudes under a clear sky the positive electricity in the air is increased. The temperature being lower also, makes this to be suspected, and it doubtless has much to do with the feeling of exhilaration which is usually experienced at medium elevations. Thunder-storms are more frequent between 3500 and 6500 feet above sea-level than at greater or lesser altitudes.

PHYSIOLOGY.

The general effects of heat and cold upon the human organism are as follows: Heat causes less food to be needed, increases the growth, but lessens the muscular force, as shown by Rattray. Dampness increases the depressing effects of heat.

Cold causes more carbonic acid to be given off and more waste of substance, does not increase growth, but inclines toward its preservation, while increasing muscular power. As evidence of how mistaken is the usual dread of cold, mortality diminishes from the equator to the poles.

The effects of damp air are so modified by temperature, pressure, and wind that one can hardly speak definitely of its action in these directions. However, there are many important points which are fairly established. The degree of absolute humidity—that is, the actual amount of vapor in so many cubic inches of air—is of consequence in breathing, since the air breathed from the lungs is not only warmed, but also saturated with moisture exhaled from the tissues and the amount of moisture already contained in the outside air, and the drier the atmosphere the greater the loss of water by the lungs. As has been shown, cold air contains less vapor than warm; therefore there is also more loss of water by the lungs when the atmospheric air is cold; so in this way the relative humidity is of consequence. Weber states that "a diminution of the secretion of the mucous membrane of the respiratory organs is a frequent result of living in dry air—a circumstance of considerable importance in the treatment of chronic catarrhal and ulcerative conditions;" and he further remarks upon the value of loss of heat by the lungs when the air inspired is cold and when its dryness demands increased evaporation, which latter, it is well known, is a most powerful agent in the reduction of heat. These facts apply to the skin by the laws of osmosis; that is, the perspiration is increased, and if the air is very dry the perspiration is not perceptible upon the skin, because the air, if it is warm, so greedily takes up the water;

and this is why in a dry climate hot weather is so much more endurable than in a damp one. The reason, again, that in a dry climate cold weather also is more endurable is explained as follows by Dr. Weber: "Heat is also lost by evaporation in cold weather when the air is dry, but the loss is not great, and can be very much limited by clothing when there is not a strong wind at the same time. On the other hand, when the air is damp the loss of heat from conduction is much greater than in dry air, and is much increased by wind; so that damp air when dew is falling feels often colder than during frost when it is dry, even though it may be ten degrees or fifteen degrees less cold." Let us further consider the functions of the skin for exhaling heat and moisture or for inhaling them, for the skin, being a damp, porous membrane necessary to produce the phenomena of osmosis, acts in both ways, and there is the effort at equalization and exchange that the law of osmosis implies. Thus, when there is greater heat or cold or greater moisture or dryness outside the skin, the usual process is reversed: first, when the temperature of the air is over blood-heat we have the body heated, and all the results which ensue from high temperature, sunstroke, etc. Then with cold, if cold is absorbed by the skin faster than the heat-producing powers of the body can compensate for, we have, first, superficial paralysis and death—that is, frost-bite; then paralysis of internal and vital organs, from which stoppage results in death of the whole system.

When the temperature of the atmosphere is at the freezing-point or lower the absorption of the cold through the skin is qualified probably in this manner: As heat relaxes the cutaneous nerves, so cold stimulates them, and the first effect of cold is to contract the fine muscles of the skin and close its pores, producing the appearance that is called goose-flesh and checking evaporation. Second, the nerves which supply the blood-vessels contract them, so that the supply of blood to the skin is shut off, thus making it temporarily as little sensitive or able to be affected by outside influences as the nails or hair; further, the blood which is thus withdrawn from the skin goes to increase the volume of the general circulation, making it brisker and more vigorous about the heart and other vital organs, and thus conveying the exhilarating sensations of cold. These are the effects produced when the cold is dry. When it is damp, as has been shown, the changes of temperature are so much less markedly felt that the nerves do not respond as readily, the blood-vessels are only slowly closed, and the blood dribbles, as it were, through the vessels of the skin, losing its heat, and thus throwing cooled blood back on the lungs and heart, causing a general chill. The fact that the damp air robs the nerves of their electric tension would be another reason why the nerves respond more tardily and imperfectly. These statements explain why in dry cold our skins

feel colder and our bodies warmer, while in damp cold we do not feel especially cold, but as if the cold was creating a draft through our very marrow. Wind of course heightens these effects in both damp and dry air. "Heat and cold, as has been stated, are better borne in dry than in damp air, but dry air combined with very low temperatures acts as an irritant to the mucous membranes of the organs of respiration, and excites a disposition to inflammatory diseases, especially pneumonia, while damp air combined with cold disposes to catarrh and bronchitis, also rheumatic and gouty affections. Damp air combined with warmth, on the other hand, exercises a soothing influence on the mucous membrane. Demands on the strength are diminished, however, by its long-continued action; the appetite and functions of the organs of digestion and the nervous system are not infrequently depressed; a kind of relaxation and diminished power of resistance to certain noxious attacks from outside appears, such as a tendency to diarrhœa, as we have often observed not only in invalids to whom we have recommended such climates, but also and still more frequently in healthy people who have been with them as companions. The separation of water by the lungs and skin is diminished in great dampness, and more work devolves upon the kidneys, while their activity is less called upon when the air is dry and warm; and we must always pay great attention to this in affections of the kidneys." Clinical observation leads me to believe that not only are the kidneys in disease relieved when the air is dry and warm, but also when it is dry and cold. There is more water exhaled by the lungs in cold air than in warm, for the reason of its greater dryness; and this may more than compensate for the lessened loss by the skin; further, the improvement in the general circulation caused by the cold must relieve the venous congestion of the kidneys and make the elimination more perfect and regular. Perhaps above all, for reasons already given, the fact that the risk of catching cold in cold dry air is much lessened may mainly serve to explain the good health I have observed in cases of Bright's disease, even in windy weather when the air was dry and cold.

"A sudden increase in the humidity of the air appears to cause a considerable modification of the functions of the body, in a manner similar to those caused by a sudden increase of heat. The separation of moisture by the lungs and skin is diminished, so it must be increased through the kidneys and intestinal canal; increased flow of urine and diarrhœa not infrequently follow" (Stewart, Hirsch, Thomas, Rohden); and if the superfluity of water is not gotten rid of in this way, the beginning of an increasing quantity of liquid in the blood-vessels is felt; and to this circumstance Rohden ascribes the increase of

hæmorrhages from the lungs on a sudden increase of humidity of the air.

THE PHYSIOLOGICAL EFFECTS OF INCREASED AND DECREASED PRESSURE are so bound up with the other conditions, such as heat and moisture, that they are not easily determined.

The experiments of Vivenot, Lange, Paum, and G. von Liebig show that by an addition of one-half to two atmospheres the lung-capacity is increased, the number of inspirations and beats of the pulse are decreased, while the pulse becomes stronger; more oxygen is absorbed by the blood and more carbonic acid given off; and the appetite is improved.

Most observations concerning increased pressure have been made in balloon and mountain ascents, and are difficult to separate from the effects of temperature and ozone; and, in addition to this, in mountain ascents the exertion used has a qualifying influence. Dr. Weber made some twenty-eight interesting observations upon persons carried up a mountain in sedan-chairs, whereby the ascent was devoid of exertion. Space will not permit me to give the details, but of them he writes: "Collecting the manifestations, we find only moderate increase of frequency in pulse and breathing in those who were not invalids at elevations of 1100 and 1500 metres, with a sensation of comfort and ease of movement, increased hunger and thirst, and diminished disposition to perspire. But a greater elevation, 3000 to 3300 metres, heightened the frequency of the pulse and breathing in many individual cases; slight muscular exertion rendered the action of the heart irregular and extremely weak, while manifestations of weakness and symptoms of mountain-sickness arose, which appeared to be caused by anæmia of the brain, and were made better by stimulants and rest in a horizontal position. In not a few cases of tolerably strong individuals the activity of the brain appeared to be remarkable at a height of over 1500 metres, in rare cases to a disquieting degree, on which depends the frequent occurrence of sleeplessness to a greater or less extent; and it is also to be remarked that a smaller number of hours of sleep generally appears to be necessary at elevations than on plains or by the sea." I myself have confirmed these observations in going to great elevations in the Rocky Mounntains, such as the summit of Pike's Peak.

That there is usually at elevations a great tolerance of alcoholic drinks is Dr. Weber's opinion, formed from his experience in the Alps, and he suggests that this may be accounted for by the rapid evaporation which occurs in rarefied air. My own observations in Colorado at a height of 6000 feet and more lead me to the conclusion that most persons are more readily affected by alcohol, and require less to procure its effects, but that the effects are more transitory; and this agrees with

what science teaches us: evaporation being more rapid in elevated places, it necessarily follows that absorption is equally speedy. As a rule, persons in high altitudes state that they use and require less alcohol than in the lower levels. I have further been led by personal observation and inquiry to believe that there is much more tolerance of alcohol, and more benefit and desire for it, in a damp than in a dry climate. I have observed this by contrasts between England and Scotland, Egypt and Colorado, in my own case and in those of others passing from one country to another. The limits of this article will not permit further discussion of this topic, but it seems probable that the amount of humidity largely modifies the direct influence of altitude in special localities with regard to the effect of alcohol on the general system.

The experiences of Gay-Lussac and Glaisher, Croce, Spinelli, Sivel, and others in high altitudes all show that it is possible to remain at a height of 7600 metres without hæmorrhage—that at 7000 metres rapid pulse, shortness of breath, and blueness of skin are experienced; at 8000 metres, difficulty in moving the limbs, and loss of consciousness on going higher, and probable death from effusion of blood.

The observations of Leyden, Lehwess, and others upon laborers who when working in mines and caissons under a pressure of two or three atmospheres suddenly return to a normal atmosphere, show as results smarting in the ears and joints, giddiness and nausea, and in some cases paralysis, from which most sufferers recovered, but in one fatal case curious furrows or rents were found in the spinal marrow.

With great moisture in the air we have distension of all the blood-vessels, especially the veins, and consequently great sluggishness of circulation. As the respiration is impeded by a slow circulation and becomes imperfect, the blood not getting thoroughly oxygenated, increased venosity—that is, more than the proper proportion of venous blood in the circulation—ensues, and the weight of the body is increased by more water in the tissues.

When, on the other hand, the air is dry, the body loses its moisture rapidly and the circulation is hastened; consequently the blood receives oxygen more frequently, and a state of increased arteriosity, to coin a word—that is, an increased amount of arterial or oxygenated blood—is produced. This quickened circulation, by stimulating the various organs, produces increased metamorphosis, especially destruction of the fats by oxidation, and the tissues are drained of their moisture. The nervous system participates in this general stimulation, especially from the more frequent supply of highly oxygenated blood to it, and the extreme results are loss of weight and fat, a too rapid waste and over-stimulation of the nervous system, and consequent rapid wearing out and incapacity for sustained exertion. The phlegmatic and corpulent

Dutchman is Nature's type of increased venosity, and the spare, nervous Yankee the best specimen of increased arteriosity climatically produced.

This arbitrary separation of the effects upon the body of the elements of heat and cold, dampness and dryness, in the atmosphere is of course not absolutely true to nature, for one modifies the other; and, above all, there are modifications with which the human organism is specially provided to combat these extremes. As man's digestion is prepared to extract nourishment from all forms of food, so is his system prepared to extract from all forms of climate what he needs of heat, moisture, and oxygen, which three elements constitute his cutaneous and pulmonary food. Let us therefore briefly consider these modifications. When the air is hotter than the body, the absorption of heat by the skin is modified by the increased perspiration, which gives rise to the cooling effects of evaporation, but to produce efficient evaporation the air must be sufficiently dry to take up rapidly the water of the perspiration; if it cannot, the body suffers the results of overheating.

It is commonly supposed that sunstroke is caused solely by the hot sun, but this is not so. Of course there must first be an atmosphere of a temperature sufficiently above blood-heat to give rise to mischief; but this granted, it is the extent to which the power of evaporation from the skin is checked that regulates the amount of damage done. This is very clearly shown by the fact that in a damp climate, where evaporation is limited, even with a much lower temperature, sunstroke is much more common than in a dry one. I have personally verified this by comparisons made on the spot in England, Egypt, and Colorado. To produce the most complete amount of evaporation from the skin, granting a dry atmosphere, there must be complete relaxation of the cutaneous nerves. This is perhaps why the drinking of alcoholic beverages so markedly increases the dangers of sunstroke by producing an irregular action of these nerves through its stupefying effects upon the nerve-centres, and in some measure by its well-known property of checking the elimination of waste products. Some observations were made in England a few years ago, comparing the amount and severity of cases of sunstroke among the harvest-laborers in the districts where they drank cider in the fields and in other districts where they drank beer, and it was found that where the stronger liquor, beer, was taken there was more sunstroke.

Geographical Distribution of Disease and Racial Distinctions.

We will now discuss the general effects of climate in causing the peculiarities of the various races of man and the geographical distribu-

tion of disease, the latter being the classification of the diseases to which man is most prone in special localities.

Man, more than any other animal, can assimilate himself to various climates, bearing the change generally without harm, and frequently with benefit. This capacity is, however, as might be supposed, much more developed in the natives of temperate climates than in those of polar or tropical regions.

The physical and intellectual differences of the various branches of the human family are justly ascribed, I believe, to climatic influences, although there are still a few who argue against this theory and believe the differences were originally impressed upon the species; in short, it is the old argument between evolution and design, in which the former has very much the best of it.

There are two facts which are prominent in the study of the effects of climate upon man in causing racial peculiarities. The first is, that commonly, if natives of one climate are domesticated in another and different climate, in the course of a few generations the descendants of these foreigners take on the racial peculiarities of the people among whom they are reared to such an extent as to submerge or modify the characteristics of their ancestors, so that it is generally difficult to distinguish them from the ordinary natives. The second is that a succession of ages has failed to impart to natives of other countries the peculiarities of the Ethiopian and Mongolian races among whom they have made their home; and this fact is an argument in favor of original conformation, though it may be only climatic effect extending over immense periods of time.

The absence of sunlight and the continuous extreme cold for two-thirds of the year produce the stunted frames and weak muscles of the Esquimaux, Laplanders, and others who reside in or near the Arctic regions; their features retain the appearance of youth till old age comes on. The intellectual and moral qualities are ill developed and torpid; the circulation is feeble and the nervous system dull; diseases assume an asthenic form, fevers being of a low type and inflammations rarely sthenic. Owing to the natives crowding together for warmth in their ill-ventilated houses, contagious diseases, when contracted, spread rapidly among them and act with virulence, but except in such cases, and except for the benumbing and debilitating effects of extreme cold and scarcity of food, they are liable to few diseases. When, however, the inhabitants of polar countries migrate to more temperate climates, they readily receive and easily succumb to febrile and inflammatory diseases, and require an especially tonic treatment.

Countries situated between forty-five and sixty-three degrees of north-western latitude are inhabited by the most robust and enduring of our species in respect to both physical and intellectual powers.

In discussing the influence of climate in causing peculiarities of race and disease, Dr. Copland[1] writes as follows: "It may be stated in general of the northern temperate zone that the inhabitants of its more southerly countries have made the earliest advances in civilization, and that those of its middle and more northerly climates have carried the useful arts and sciences to the highest perfection. Within the range of this zone man presents the greatest diversity of temperament, of constitution, and of mental endowment. Muscular frames, plethoric habits of body, and the sanguine temperament predominate among the natives of the more northerly of temperate climates, particularly as regards Europe and its western countries. Affections of the chest and respiratory organs, inflammations, fevers complicated with inflammations of the lungs or of the brain, and rheumatism, are the most prevalent diseases.

"Epidemics assume most frequently amongst them a phlogistic character, and vascular depletions are more required and better borne in the treatment of their maladies. Climates which are the most variable as to both the commencement and the course of the different seasons are, notwithstanding the many disadvantages imputed to them, the most favorable to the advancement of the various bodily and mental powers. The rapid and frequent vicissitudes of weather preclude, as respects the community generally, the regular adoption of means to guard the body against their operation; consequently, the frame becomes habituated to their operation, and thereby fortified against the injurious impressions which would be otherwise made by them. That countries thus circumstanced are benefited rather than injured by this state of weather and season is shown by the robust frames, the mental activity, and the longevity of their inhabitants. The physical and moral history of the British Isles, Denmark, Sweden, and the more continental districts of Western Europe demonstrate this fact. In the eastern countries of this quarter of the globe, as well as in Central Asia and in North America, the seasons being much more regular in their advent and in their course, measures are more regularly and uniformly adopted to moderate the extremes of temperature and the vicissitudes of weather; and these have in many instances the effect of enervating the frame, of promoting the extension or prevalence of disease, and of thereby diminishing the mean duration of human life. Of this description is the use of excessively warm clothing, and of stoves which overheat the air of the apartments without renewing it as rapidly as is often requisite to the wants of the economy. Hence, whilst the external atmosphere is cold, dry, and invigorating to the healthy frame in a state of activity, the air indoors is close, warm, and

[1] *A Dictionary of Practical Medicine*, by James Copland, M. D., F. R. S., London, vol. i. p. 343.

depressing, the frequent alternation from the one to the other, or the constant residence in the latter, being injurious even to those in health and causing diseases of the thoracic and abdominal viscera.[1]

"While the natives of northerly inland countries suffer more especially from the extremes of temperature and of season, and the circumstances which arise out of them, they are less exposed to those emanations which arise chiefly from the decomposition of vegetable and animal matter, and to those endemic sources of disease that produce so much suffering and mortality in low or level districts and in more southerly climates, where the atmosphere is moist and warm. The inhabitants of temperate countries considerably elevated above the level of the sea, and of mountainous places, are generally of a spare, firm, and muscular habit of body, and strongly formed, chiefly owing to their active and industrious modes of life and the pure and light state of the air they breathe. The irritable, sanguine, and nervous temperaments, and quick, irritable, and generous dispositions, predominate among them. Inflammatory, hæmorrhagic, and spasmodic diseases, particularly hæmoptysis, bronchitis, consumption, asthma, inflammations of the lungs and pleura, rheumatism, and disorders of the circulatory organs, are most common. Their females are more virtuous and prolific, and the mean duration of human life longer, than amongst the natives of lower districts and warmer climates.

"There are certain peculiarities in the natives of countries, particularly of European countries, that must strike the pathologist as intimately connected with the nature and treatment of their diseases. These are chiefly the complexion of the skin, the large development of the respiratory and biliary, nervous, and circulating organs, compared with those of the natives of intertropical countries. The skin of the dark races is not only different in color, but it is also considerably modified in texture, so as to enable it to perform a greater extent of function than the more delicately-formed skin of the white variety of the species. The thick, dark rete mucosum of the former is evidently more suited to the warm, moist, and miasmal climates of the tropics than that with which the latter variety is provided. The skin of the negro is a much more active organ of depuration than that of the white. It not merely exhales a larger proportion of aqueous fluid and carbonic acid from the blood, but it also elaborates a more unctuous secretion, which by its abundance and sensible properties evidently possesses a very considerable influence in counteracting the heating effects of the sun's rays upon the body and in carrying off the superabundant caloric. Whilst the active functions, aided by the color of the skin, thus tend to diminish the heat of the body and to prevent its excessive

[1] This applies with great force to the habitations of the average American citizen. —S. E. Solly.

increase by the temperature of the climate, those materials that require removal from the blood are eliminated by this surface, which, in the negro especially, performs excreting functions very evidently in aid of those of respiration and of biliary secretions. In the white variety of the species, on the other hand, the functions of the lungs and liver are much more active than in the darker races, changes to a greater extent being performed by respiration in the former than in the latter, as I have proved by experiment. The liver is also larger, and its secretions more copious, in the European than in the negro or Mongolian.

"In the inhabitants of northern climates and elevated or cold countries the functions of the lungs and kidneys are extremely prominent, and those of the skin and liver much less so, eliminating or depurating actions on the blood being performed chiefly by the former organs. But in the natives of intertropical climates the skin assumes, as shown above, a more extensive function, and by its activity compensates for the diminished operation of the lungs, liver, and kidneys generally observed among them, aided, no doubt, by the secretions from the intestinal mucous surface. In temperate countries the various emunctories of the frame present a degree of activity in strict keeping with this general connection of climate with the development and activity of these functions. In the warmer districts of temperate climates, and especially those which are subjected to a dense, moist, and miasmal atmosphere, the changes produced by respiration are diminished, and those effected by the cutaneous and intestinal mucous surfaces are increased. If the natives of such districts belong to the white variety of the species, their cutaneous surface not being constituted so as to enable it to perform the compensating action for which the skin of the darker races is destined, a different organ performs this office, and the liver assumes an increased action, combining and eliminating several of the effete constituents or elements as they accumulate in the circulation, thereby giving rise to an increased and modified biliary secretion.

"As the physical and intellectual powers of man enable him to occupy the whole surface of the globe, it follows that he cannot be restricted to any particular kind of food; in other words, he must be naturally omnivorous as a consequence of his ubiquity.

"It appears to be a salutary law of nature that in those climates where animal food would be detrimental to the human race, there the animals usually destined for the purpose are few in number and stunted in growth. The localities, indeed, which are the most destructive to man are also the most inimical to these animals, which, if they were chosen as the chief article of food, would both dispose to disease and increase its fatality. Thus, it appears that the distribution of the classes of animals over the surface of the globe is so apportioned, and certain of their orders and genera so restricted to particular latitudes and climes,

as to be subservient to the wants of man, without becoming hurtful or endangering existence in countries in many respects unfavorable to his bodily and mental development.

"While the vegetable diet which the hottest and most unhealthy climates furnish is the least liable to excite the nervous system, or to overload the circulating and secreting organs, or to irritate and inflame the excreting viscera, it serves to promote endurance, and, with the hot spices which grow spontaneously in the same localities, to counteract the contaminating changes produced in the body by the vegeto-animal effluviæ to which it is frequently exposed.

"From these and other considerations the following corollaries may be drawn: That the climate of a country should, in a great measure, guide man in his selection of food, those productions which are most abundant around him being most appropriate to the circumstances in which he is placed; and that the nature of his food thus conspires with the climate to modify his constitution, whilst it serves to counteract the rigors of season and the unwholesome influences to which he is constantly exposed in very hot as well as in very cold countries."

Classification of Climates.

This is at the best extremely unsatisfactory, the important elements being so interlaced as to make a complete disentanglement of them for the purpose of grouping climates under separate heads almost impossible. For some purposes the classification which may be termed a geographical one is the best; that is, into two grand divisions—viz. sea and inland, and these again into sea, island, and coast under the first head, and plain and mountain under the second; whilst for others the division into cool and moderately damp, cool and very damp, cool and moderately dry, cool and very dry, warm and moderately dry, and warm and very dry, has much to recommend it; however, in all these divisions there are the objections that pertain to generalization.

Sea Climates.—The climate of the ocean of course varies considerably in different latitudes and under the remote effects of the land upon ocean-currents, as in the case of the Gulf Stream, where the waters heated in the Gulf are poured into the ocean and carry its heat for many thousands of miles, or, on the other hand, where the waters from the polar regions bring the melting icebergs toward southern latitudes. Apart from these special influences, however, the most marked characteristic of our ocean climate is its equability, not only of daily temperature, but also lessened contrast between day and night, summer and winter. The reason for this is mainly on account of the water absorbing the sun's heat by day, and then returning it to the atmosphere by night. On shore the earth's surface absorbs but little of the sun's heat, and instead radiates it back

into the air at once, thus greatly increasing the aërial temperature, while at night, there being little heat to be returned from the earth, the natural cooling of the air goes on without being mitigated, as it is over the ocean, by the heat from the water being returned to the air.

Another marked and constant characteristic is the great humidity of the air, due to the vapor given off from the water. This, of course, acting as a veil, lessens the force of both the sun's light and heat by day, by absorbing much of it as it passes through. At night this stored-up heat is given off, thus lessening the sharp contrast between day and night; and a similar change prevails between winter and summer. The sea-air is impregnated with saline particles, and in small amounts by the gases of iodine and bromine, and is free from dust and germs. The amount of ozone is always very large. The electricity is more negative than on shore, a return to equilibrium being more easily established. There is of course great mobility of atmosphere, and, owing to the absence of any wind-breaks, heavy winds often carry the climate of distant coasts over the ocean, and thus its natural equability is greatly modified.

Physiological Effects.—The study of the physiological effects of these conditions has been very imperfect, but we are indebted to the valuable researches of Beneke for certain facts. A warm liquid cools more rapidly under like conditions on the sea-shore than inland, and particularly so in contrast to elevated regions; therefore the loss of bodily heat is greater at the sea. Experience tells one that warmer clothing is needed, in proportion to the temperature, on the sea than on the mountains. There is also an increased metabolism shown by the presence in the urine of more urea and sulphuric acid and less uric and phosphoric acid, and the body's weight is increased. These effects, Beneke demonstrated, are produced more by sea-air than sea-baths. The constant movement of the air doubtless has much to do with this. Most observers, with whom Weber agrees, assert that as a rule the rate of the pulse and respiration are lowered on the sea, due without doubt to the great barometric pressure and increased humidity. As a generality, it may be stated that sleep and appetite are increased, and that the effect on the nervous system is that of a sedative. There are of course many exceptions where the opposite results are markedly produced. The continued effect upon those with whom the air agrees is to increase the blood-supply and strengthen the nervous, circulatory, and cutaneous systems. In short, the influence upon suitable temperaments and conditions is that of a sedative tonic.

Therapeutic Application.—The effects of any climate, and therefore sea-air, on pathological conditions and disturbances may be divided into those which are general and those which are special, those which are negative and those which are positive.

In the first place, a removal to the sea ensures the advantage of freedom from mental worry or toil, and from impurities of atmosphere and surroundings, without, however, what is often a practical drawback to sea-voyaging, possible lack of hygiene in the vessel itself.

The general advantages are those of pure air, much ozone, and outdoor life. These it shares more or less in common with all health-resorts. Its more special effects are through its humidity and equability and its electrical influence in tranquillizing the nervous system, and secondarily the circulatory and cutaneous systems. It is therefore beneficial where there is much nervous irritability and where degenerative changes are in progress. I have observed benefit from sea-air in many chronic nervous diseases of both old and young where change of structure was or had been progressing, whereas I have yet to see such cases benefited under the extreme opposite of climate—viz. on the mountains. The nervous irritability which accompanies a full habit is usually best suited to a sea climate, while the irritability that is associated with a feeble circulation is more surely relieved at an altitude. With regard to diseases of the heart and great vessels, it may be stated as a generality that they are much more apt to be improved on the sea than on the mountains, though there are notable exceptions to this, as in the experience in the Andes of Dr. Archibald Smith, who saw improvement in cases of aneurism. My own observations in Colorado confirm this. The benefit derived in certain conditions of valvular lesions by mountain-climbing and residence has been demonstrated by Oertel and others. With respect to hepatic affections the question is one that is largely influenced by temperament, which the humidity controls. The man who is made bilious by sea-air is generally of dark complexion and spare habit, in whom inquiry reveals the fact that he feels best in dry and often in frosty weather, while the blond with a tendency to a full habit generally is at his best when the air is humid and also when it is warm. Kidney affections are frequently benefited by sea-air when the temperature is high, by reason of the equability, and in spite of the humidity limiting the relief to the defective organ by the lack of vicarious elimination through the skin. Some renal affections are more benefited on the mountains, where the dryness of the air is of sufficient value to counterbalance the objection of inequability. On the whole, however, these diseases may be said to do better in warm sea-air than in warm mountain-resorts. In regard to scrofulous affections, I was much struck some years ago by the improvement in the children at the Infirmary for Scrofula, which is on the warm sea-shore of Margate, while I was attending there. I have, however, since seen better results in Colorado, and much less disease among the inhabitants. The benefit derived from sea-air in scrofulous affections is probably due to the gen-

eral and negative influences, and not to the special and positive. As regards pulmonary affections, diseases of the air-passages accompanied by much cough and a lack of free secretion from an irritable mucous membrane are apt to be benefited. I found this the case on the coast of Southern California, which I recently visited, whereas such cases do badly on the mountains; and this is true for the most part even when accompanied by tuberculosis, chronic pneumonia, and pleurisy, while, on the other hand, most cases of phthisis are usually better away from the sea.

Island Climates.—By these are understood only the climates obtainable on islands of moderate size: these if at a fair distance from the mainland often enjoy most of the qualities of a pure ocean climate, without the drawbacks of ship-life, and of course are influenced by latitude, ocean-currents, soil, and configuration.

Coast climates partake more or less of the characteristics of both sea and land. They have less equability, owing to the different radiation from land and water, as spoken of before. The humidity may also be greatly lessened by the proximity of deserts, as in Northern Africa and Southern California. Again, the precipitation is often changed considerably. Thus coast climates, though resembling in general qualities the ocean climates, have wide ranges of difference, so that life at the shore, on the sea, and on an ocean island have great contrasts and yet a strong family resemblance.

Inland Climates.—Inland climates of low elevation have certain physical peculiarities, and, occupying as they do a position between sea and mountain climates, have for the most part, like those of the sea, high barometric pressure, lessening with elevation, and more or less humidity, diminishing, as a rule, with the distance from the ocean. The intervention of mountain-ranges, however, such as the Coast Range of California, will cause the precipitation of the moisture of the sea-air, and thus give a comparatively dry air on the land side of the range at only a short distance from the sea. The dryest low inland climates are nevertheless generally found in the interior of the continents, most remote from the ocean. The humidity, again, is modified not only by proximity to the sea, but also to great lakes, rivers, and swamps, and further by the vegetation and quality of the soil. The mean temperature varies, in the main, with distance from the equator, while the variations between day and night, sunshine and shadow, summer and winter, being dependent on the amount of humidity, increase, as a general rule, with distance from the ocean. There are, of course, marked modifications of this, as where desert lands approach the sea or, as referred to, mountains intervene. The air is necessarily less pure and the amount of ozone less than on the sea.

The main division of low inland climates is into moist and dry,

and these again into moist and warm, moist and cool, dry and warm, dry and cool.

The moist and warm combination, when extreme, is altogether unsuitable for therapeutic purposes, giving the hot damp climates where malarial and other fevers, such as yellow fever, abound. Coming between these and the next class are *the moderately moist and warm climates*, which, though generally occurring as coast climates, may be inland also, such as Florida and the coast region of Southern California, the climate of Florida being, on the whole, rather the more moist and warm. These climates act chiefly through their sedative influence upon the nervous system and the mucous membranes, and during their appropriate seasons the moderate rainfall and equable warmth allow of much outdoor life; and they are especially useful in affording an agreeable change in winter for those inhabitants of colder regions who desire for comfort or safety to avoid the rigor of their home climate. Moderately moist and warm climates are also often used by invalids with great benefit. Such climates are found at Rome and in Persia and the Riviera in Europe, and on this continent at Asheville in Western North Carolina (elevation 2250 feet), and at Aiken in Western South Carolina and Marietta and Thomasville in Georgia. The general indications for the therapeutic use of such climates is where the extreme effects of climate, such as are produced in sea- and mountain-air, are undesirable or dangerous.

Moderately moist and cool climates may be termed indifferent, having no marked characteristics, but are often of service on account of their accessibility and pleasant surroundings and encouragement to diversion of mind and body. Many of the mineral springs that are largely used are situated in such climates, as Baden-Baden, Wiesbaden, and Saratoga, and resorts in the foot-hills and sub-alpine places are mostly in this category. In America, Evans[1] places in this group, with a general elevation of 2000 feet, the western slope of the Appalachian chain, the Adirondacks, and the Alleghany and Cumberland mountains. These, owing to their elevation and purity of air by reason of being mostly in uncultivated and sparsely-inhabited regions, have more positively beneficial qualities than the lower places first referred to. Pine forests and the opportunities for sport and camping also add much to their value.

Moist and cold climates are quite unsuited for therapeutic use, being the producers of rheumatic and catarrhal affections, as well as the breeding-ground of much of the phthisis that everywhere abounds.

Dry and warm climates are greatly used by invalids, and often with benefit. Such climates are practically not to be found in Europe. The west coast of Africa, Egypt, and Nubia, the Steppes of Tartary, and

[1] *Phthisiology*, by G. T. Evans, M. D., D. Appleton & Co., N. Y.

on this continent South-western Texas, the inland regions of Southern California, and the less elevated regions of Arizona and Utah, come within this class. Egypt may be taken as a type of the dry warm climates, and of this Dr. Weber writes that he has notes of 24 cases of phthisis, which spent from one to four winters in Egypt; of these, 6 were in the first stage, with 4 cases improved and 2 grown worse; 12 in the second stage, with 6 improved, 3 grown worse, and 3 with no positive change; 6 in the third stage, with 2 improved, 3 grown worse, and 1 no decided change—a total improvement of 50 per cent. of the whole 24. In the first stage 66.6 per cent., second stage 50 per cent., third 33.3 per cent., were improved.

In 10 cases of emphysema with chronic catarrh, 9 improved. In 16 cases of chronic rheumatism, 14 improved. Out of 9 cases of chronic gout, 8 improved. In several patients with long-continued diabetes, who were at or past middle age, improvement was noted. Of 11 cases of albuminuria, 4 improved, 4 remained stationary, 2 grew worse, and 1 died. Some cases of heart disease with bronchial catarrh and digestive disturbances did well; so also did some with neuralgic affections, premature ageing, and nervous exhaustion from mental work or business care.

I visited Egypt several years ago, remaining six months, from October to April, during which time I frequented the hospitals in Alexandria and Cairo. At the latter point I remained some time, making excursions from it, and then spent four months on the Nile, going into Nubia as far as the Second Cataract, during which time I was frequently consulted by visitors and by invalids, both native and foreign. The conclusions I formed of the effect of the climate upon disease confirm what I have quoted from Dr. Weber.

On this continent the regions with an elevation of less than 2500 feet, which are similar to Egypt in climate, have been but little used, and have at present few means of ensuring comfort and resource for invalids. Portions of Western Kansas and Southern Arizona are somewhat similar in climate, more particularly the latter, and, as far as can be ascertained, tend to benefit much the same class of diseases. It is, however, not practical at present to send patients to them, though I have known benefit derived in both where a greater altitude did not agree, and yet dryness was desirable.

Weber says *dry and cold climates* are not yet used therapeutically; he has seen 4 cases of phthisis in the first and beginning of the second stage, when business took them to Labrador, 3 of whom entirely recovered in the course of from four to six years. The fourth was unimproved. All four patients were powerfully-built men, free from other disease and without hereditary taint. Thus, the four cases, Weber says, might be called "selected," and he would not advise the climate

for weakly persons. I had under my care in Colorado a patient of fine physique who had tuberculous ulceration of the larynx and consolidation at one apex. While in this condition, and having the pulmonary symptoms with aphonia and dysphagia, he went on the Greely relief expedition to the North Pole, and while under the influence of the dry cold air all his symptoms improved. Returning to the Eastern States, he got worse, came to Colorado, improved again, his larynx healing, and with all the signs of arrested disease he went back East, and there succumbed to a general tuberculosis, dying ultimately from meningitis. In a less degree, during the winter season the climates of parts of Canada, Minnesota, Nebraska, and Dakota rank in this class. Benefit to cases of pulmonary tuberculosis in an early stage and in robust persons are reported from all of them, but the cases that will do well in such climates do far better for the most part, and more certainly, in dry, elevated regions.

Elevated Climates.—The first in importance of the physical peculiarities of elevated climates is rarefaction, or lessened barometric pressure, while the next peculiarity of importance is coolness of air, with, at the same time, greater direct heat from the sun, especially in winter. The temperature of the air is very slightly raised by sunshine passing through it, for the reason that there is so small an amount of moisture in it. For this reason the sunshine is very hot and the air very cool in elevated climates, and these contrasts are especially marked during the winter, owing to the greater dryness at that season.

The dryness of the air—that is, both the absolute and relative humidity—is low in elevated climates, though the rain- and snowfall is sometimes considerable, and the movement of the air, except in sheltered valleys, is constant and not excessive, though wind-storms are common.

In elevated climates the air is aseptic, for there is very great freedom from inorganic and organic impurities and miasmata. The causes of this are not determined, but they may be due to the following conditions: first, to the low humidity, bacteria and kindred micro-organisms thriving better in damper air; second, to the cold nights, destroying many forms of life; third, to the perfect oxygenation, the oxygen not being replaced by other and noxious gases; and, fourth, possibly by the greater energy of the electrical state of the earth and air. However, where unhealthy conditions exist, as in crowded cities with numerous invalids, even at a considerable altitude, the aseptic quality of the air disappears.

The increased light of elevated climates has been shown, by the experiments of Downes, Blunt, and Moleschott, to destroy bacteria and increase oxidation; and there is a relative increase of ozone, which is

presumed to be allotropic oxygen, or, in other words, oxygen in an especially active state.

Positive electricity is also present in a higher degree, and dryness of soil usually exists.

The General Physiological Effects.—The activity of the skin is increased, and it is better nourished and strengthened in an elevated climate, and the heart and vascular system also are probably strengthened. The frequency of the contraction of the heart is certainly increased at the beginning of the stay in such climates, but returns to the natural number of beats after a time. The individual contractions are stronger, and in this manner the strength of the circulation is increased.

The number of respirations is increased at first, but returns to the natural number after a time, and the depth of the inspirations is probably increased. The respiratory muscles are strengthened, and probably also the elastic fibres of the finest bronchial ramifications. The blood in the lungs is also increased in quantity, while the amount of water eliminated by the lungs is usually considerably augmented, and the separation of carbonic acid rendered more free.

As a rule, there is either a transient or permanent increase in the appetite and in the assimilation of nourishment, and consequently an improved formation of blood and nourishment of these organs ensues.

The nervous and muscular systems become stronger in elevated climates, and sleep is generally improved.

General Pathological Effects.—Dr. Ludwig, in his prize essay upon the Upper Engadine, shows that at high elevations there is an increased mortality in the following diseases, which are those most commonly known there: Acute bronchitis, acute pneumonia and pleurisy, catarrh of the mucous membranes of the air- and digestive passages and of the conjunctiva, rheumatic and neuralgic affections; also certain forms of anæmia and cardialgia, which occur in women from unsuitable food and ways of living.

In this region it is rare to find cases of chronic pneumonia, phthisis, hæmoptysis, scrofula, hæmorrhoids, intermittent fever, and similar diseases.

Therapeutic Application.—The difference, writes Dr. Weber, in the therapeutical action of the various elevated climates is very great, varying with their height, latitude, direction toward the points of the compass, and configuration of the surrounding country. It may be said, however, that, as a rule, the character of a mountain climate is stimulating to most functions, and that it has a powerful therapeutic action, although it requires a certain integrity and resisting power of the constitution to attain this desirable effect.

The *diseases which are favorably influenced* by an elevated climate are loss of appetite and disturbance of the stomach from lack of exer-

cise and pure air, with the ordinary consequences, such as anæmia and chlorosis. In chronic catarrh of the throat and bronchial tubes such a climate assists the secretion of mucus. The results of malarial poisoning, as sluggish circulation in the abdominal organs, hæmorrhoids, and hypochondria, are improved, as are also anæmic disturbances of nerve-action, such as neuralgia, slight hysterical conditions, and nervous polyuria. In most cases of nervous and bronchial asthma which do not depend upon emphysema and organic disease of the heart and blood-vessels, and are not complicated with them, benefit is obtained, and sleeplessness from overwork or exhaustion without mental disturbance is overcome. Weakness of the skin, a poorly-developed chest, a tendency to consumption, consumption itself, and scrofulous diseases are improved, though these are generally more benefited at the seashore.

The *diseases which are unfavorably influenced* include most cases of organic disease of the heart and vessels, though a heart moderately enlarged with a weak muscle, even with a bruit, is often improved, and generally much more so than on the coast. Even cases of aneurism of the aorta are often relieved. A notable case of this character, which occurred at Jauja, Peru, 9000 feet above the sea, is related by Archibald Smith.

Atheroma and senile affections generally contraindicate a high climate, and chronic bronchitis with great enlargement of the tubes and much emphysema is made worse. Epilepsy is also usually made worse, though experience on this point is very limited. In cases of lunacy, when there is a tendency to agitation, high climates do harm. They are also unsuitable for rheumatic affections and in the presence of much general debility with inability to bear wind, cold, or change of temperature. Generally, old persons and infants are better on a warm seashore.

Such is the summary of views of the observers at altitudes in Europe and elsewhere. My own observations in Colorado at similar elevations agree very closely with them, though there are some points of difference; but, as they do not much affect the main issues of the question, we will not discuss them.

Diseases in which Climatic Change is Indicated.

The disease must be of a chronic character, though occasionally a change during an acute stage of the illness is called for, as when the heart or nervous system is being unfavorably influenced by the climate in which the invalid is placed. Acute tuberculosis also is often arrested by a suitable change. The most important of the diseases for which change of climate is properly prescribed is tuberculosis, especially that of the lungs. We will therefore proceed to inquire into the influence of climate upon phthisis with regard to its production.

Phthisis.

What are the essentials of a climate for the cure of phthisis? The first and most important, and the one upon which all writers are agreed, is *purity of air*—not necessarily antiseptic air. The air being the chief food of the lungs, which are the parts in which the lesion exists, must necessarily be pure in order to effect an improvement. For this reason we find from the researches of Hirsch, Weber, Evans, Copland, Woeikof,[1] and others that there is least consumption among the people who dwell on mountains or on open and comparatively uninhabited plains, such as the Great American Desert, the African Desert, and the Steppes of Tartary, and on certain islands and sea-coasts. Although there is no zone of freedom from phthisis upon the surface of the land or sea, it being found everywhere, yet, as has been stated, it is relatively rare in the following order—viz.: On certain sea-coasts, on certain islands enjoying as nearly a pure ocean climate as possible, in desert places of wide extent, as found in the interior of continents, in polar regions, and, finally, most rare at elevations and increasing in rarity with altitude. Further, the experiments of Brown-Séquard, Stokes, Trudeau, and others show that when animals which have been successfully inoculated with bacillary matter are kept in confined spaces with imperfect ventilation, they become tuberculous, while those which after similar inoculations are kept in open-air quarters escape the disease.

In regard to *temperature*, Hirsch[2] shows the fallacy of the theory, on the one hand, that consumption is most common in cold or temperate climates, and on the other that it is not common in warm and hot climates; and he further states that "the mean level of the temperature has no significance, as will be seen from the facts already given, and particularly from the statistics of mortality for the frequency or rarity of phthisis in any locality." But it exercises a very decided influence on the course of the disease; for, according to nearly all authorities, in tropical countries, including India, Cochin China, China, the Pacific islands, the Andes, the west coast of Africa, the West Indies, Panama, Guiana, Brazil, and Peru, consumption usually runs a much more rapid and pernicious course than in higher latitudes, the removal of the patient from such a climate as speedily as may be being in fact the only sure protection against a rapidly fatal issue.

During a practice of sixteen years' duration in Colorado, largely among the consumptive visitors, I have observed that in those in whom the disease had developed in warm climates the malady was usually much further advanced in the same length of illness than in those coming from cool climates, and that the tendency in most of the former

[1] *Die Klimate der Erde.*

[2] *Handbook of Geographical and Historical Pathology*, vol. ii.

cases was to run a more rapid course and more frequently to end fatally than in the latter.

Severe and sudden changes of temperature from day to day have no more determining influence, *per se*, than has the absolute height of the temperature. Hirsch refers to the evidence furnished in abundance from numerous places in the more elevated regions of North and South America which are little touched by the disease, although they are subject to very severe fluctuations of temperature. The evidence shows that *variability with dryness of air* has at least no prejudicial influence on phthisis, except, of course, in some special cases; and there are many theoretical reasons, and I believe good practical ones also, as will be shown later, for believing these qualities to be beneficial.

Hirsch has shown that *variability with dampness of air*, when conjoined with frequent oscillations of temperature, predisposes to phthisis, while, on the other hand, *damp heat* has been shown not to have a positive influence in its production, but a very decidedly unfavorable one upon its progress when once established.

Damp cold, however, is proved to be very positively active in the production of consumption, and most injurious to those in whom it has developed; and *dampness of soil* has been incontestably proved by the investigations of the elder Bowditch, Buchanan, Milroy, Pepper, and many others to be a most potent factor in the production and progress of phthisis—very much more so than dampness of air, either hot or cold.

Humidity of the air does not in itself, apart from other factors, apparently produce phthisis: the comparative immunity from consumption among the men of the British navy contrasted with those of the army, and the rarity of the disease upon many islands, such as the Faroe, the Shetlands, the Hebrides, and Iceland, show this. The influence of these climates and of sea-voyages on the disease when developed and active has, however, not been shown by the evidence of others or by my own observation to be beneficial, removal from the sea being generally of most advantage. Where benefit has been received in a sea climate, it would appear probable that it was owing mainly to the great purity of the air or the elimination of unsanitary conditions and hurtful occupations, as when an overworked citizen takes a sea-voyage or a Bostonian is sent to such a climate as the Isle of Shoals, or a Philadelphian to Atlantic City. Therefore, it is fair to assume that the beneficial influence of humidity upon phthisis, apart from other climatic factors, when it occurs, is purely negative. This does not, however, prevent the possibility of its being of positive benefit in occasional cases of phthisis in which the accompanying conditions of the circulation, nervous system, or mucous membranes demand a damp climate.

Dryness of air, on the contrary, has been known to be of positive benefit to the consumptive. The excellent results obtained from desert air (apart from altitude, which we will consider later) are too well known to quote at length. The benefit derived from the Steppes of Tartary is often mentioned, and I myself have, while on the spot, noted remarkable results produced by the climate of Upper Egypt and in Arizona and the Mojave Desert, lying behind the littoral of Southern California. Some years ago, while practising in London, I noted great improvement in the general and local signs of phthisis in several cases of consumption which were tending to deteriorate, after they had been employed for several months as shampooers in the Turkish baths, where they lived for most of the twenty-four hours in a very dry and superheated air. That the dryness, and not the heat, was the cause of the improvement may be fairly inferred from the fact that hot moist climates are not beneficial; and I may add that, from inquiries I have made in Egypt and elsewhere, where the so-called Russian or hot vapor-baths are in vogue, consumptives are very properly warned against their use.

With respect to the rarity of phthisis in dry low climates Hirsch writes as follows: "There are few countries of the world so characterized by uniformity of temperature and comparative dryness of the air as the inland districts of Lower Egypt and the valley of the Nile in Central and Upper Egypt—regions in which phthisis, according to all observers, is very uncommon. On the other hand, as we have already seen, localities on the coast, such as Alexandria, Damietta, and Port Saïd, with a moist climate and a great range of temperature, are much more subject to the disease. The same relation between the sort of climate and the number of cases is found in the interior districts of Algiers on the one part, and the coast-belt of that country on the other. In India, says Hunter, the localities specially distinguished by dryness of climate (and uniformity of temperature), be they on the plains or among the hills, are least affected by phthisis; and the same relationship may be discovered in Java, in the Gulf States of the American Union, in Mexico, in Guiana, and in many islands of the West Indies. It is a probable conjecture that the way in which the climate affects the amount of disease is through the particular states of the weather (high degree of atmospheric moisture along with great variations of the thermometer), causing catarrhal affections of the bronchial mucous membrane and the after-effects of the same—that the climatic influence, accordingly, is in all probability a real predisposing factor in the development of phthisis. It is from the same point of view that we may explain the beneficial effects of the climatic treatment of consumption—a treatment which consists in withdrawing the subjects of phthisis

or those who are threatened with phthisis from these harmful climatic influences."

In crediting dryness of air, *per se*, with a beneficial influence upon phthisis, we must not forget that some share of the credit at least belongs to the other necessary accompanying factors of a dry atmosphere—namely, more powerful sunlight and heat, less depressing cloudy weather, cooler nights and shade, and a higher electric tension of the body. What is also of prime importance is the greater opportunity for exercising and resting in the open air and while the invalid is in the house, the windows being open by day and by night.

In regard to *altitude*, observers have differed as to the least degree of elevation at which its special characteristics are manifested, some placing it as low as 1500 feet, but most writers at 2500 feet, which is probably the more correct. What Hirsch writes concerning the relative immunity of great altitudes, and his theory of the cause, are so pertinent and valuable that I will quote him at length: "The observations published by Archibald Smith and Tschudi as to the extreme rarity of phthisis on the high plateaus of the Andes in Peru, and as to the good effects upon the phthisical of a residence thereon, were the first statements to direct general attention to the comparative immunity from consumption of regions at a great elevation. Further inquiries in the same direction have confirmed the general fact, but they have in part also given color to an opposite conclusion, so that the question may be said to be still *sub judice* for those who would decide it absolutely and without regard to accessory circumstances.

"It is not to be denied that phthisis does occur at the highest inhabited spots on the globe, and that it is rare in many places situated on low plains; none the less, it is an incontestable fact that consumption is, *cæteris paribus*, much less frequently met with at high-lying places than in those at a lower elevation or on the sea-level. Not only so, but the number of cases stands in some kind of definite proportion to the degree of elevation, while the exceptions to the general rule find satisfactory explanation in other etiological factors coming into play at the same time."

The rarity of phthisis at high elevations is well shown in the returns of sickness from that most extensive of the earth's mountain-chains which runs along the whole Pacific coast of the Western Hemisphere. For the Rocky Mountains of North America we have evidence of the fact from a number of places in the Territories situated toward the southern end of the range, such as New Mexico, Arizona, Colorado, and also Utah. In like manner, all the authorities speak of the rarity of the disease on the plateaus and mountain-slopes of Mexico, Guatemala, Salvador, Costa Rica, and Panama (for example, on the Cordilleras of Veragua and Chirigui). From Bogota, in New

Granada, Holden writes that he did not see one consumptive person in the hospitals of the town during a prolonged residence there. Referring to Quito (Ecuador), Gayraud and Domec say: "Notre expérience personelle nous permet d'affirmer, que la phthisie y est tellement rare qu'elle n'y existe pas, au moins comme maladie prenant naissance dans le pays lui-même. . . . . Le fait est donc pour nous indubitable, on ne devient pas phthisique à Quito." For the Peruvian Andes we have the statements of Smith and Tschudi, already mentioned. During a year's stay on the Cerro Pasco the former saw only one case of consumption, and that was in a woman who had come from Europe.

"There is no doubt," says Andrew, "that as regards altitude the prevalence of phthisis at considerable heights, although instances of it do exist, is exceptional; and Burkhart mentions that he had not seen a single case of phthisis during a period of three months among the Europeans occupied at the mines in Mexico.

"In those parts of the Argentine Republic that are within the limits of the Andes the influence of high elevations upon the rarity of phthisis is observable as far down as Salta; it is still more obvious in the elevated valleys on the western side, as well as on the Bolivian plateau at Chuquisaca, Cochabamba, Potosi, and other places. In the mountainous parts of Guiana also consumption is almost unknown."

In the Eastern Hemisphere this immunity from phthisis is shown most decidedly on the plateau of Armenia, where the disease is found almost solely among those who have come from less elevated places; also on the table-land of Persia, where it is extremely rare, and among the natives of the country almost unknown; on the northern and southern slopes of the Himalaya, at the elevated points of the Western Ghats, on the Nilghiri Hills, on Mount Abu (4000 feet) in the Aravalli range, and in Nearer India; on the plateau of Abyssinia and on those of Southern Africa.

In Europe a certain rarity of phthisis begins to be noticeable even at comparatively small elevations, as in the Iser range, on the northern spurs of the Carpathians, in Upper Silesia, on the elevated plain of Thuringia, in the Upper Hartz, and in the Spessart. Writing of Upper Silesia, Virchow says: "Although I have seen an exceptionally large number of sick persons of the poorer class both in town and country, at their homes and in hospital, yet there has not come under my notice a single case of phthisis; and the statements of the medical men bear out the notion that the disease is rare. In the Upper Hartz consumption is so unusual that Brockmann, during a practice of many years and extending to eighty thousand sick persons, found only twenty-three phthisical patients, of whom only fourteen had been born in the Upper Hartz; in the lower valleys the malady is more common, but the high plateau is almost exempt." In Spessart, according to Virchow,

phthisis is not so rare, although in the larger villages he met with only an occasional case, and the registers of deaths rarely contained the entry of consumption or decline. I shall add here the interesting note by Gross, that consumption is almost unknown in Briançon (Hautes-Alpes), the most elevated town in Europe (1306 metres, or 4285 feet), although the place is a small fortress with a good deal of filth and a number of industries. Statistical inquiries, such as have been carried on in Saxony, Baden, and Switzerland, on the amount of phthisis in the elevated places as compared with low-lying places close at hand (due regard being had to any differences in the mode of life), have confirmed the law of immunity of the more elevated places from phthisis which had been deduced from the study of the higher elevations by themselves. The following is Merbach's table for Saxony, based on a period of three years from 1873 to 1875, and including only those towns with upward of five thousand inhabitants, and only the ages between fourteen and sixty years:

Altitude in Metres (= 3¼ feet).	Deaths from Phthisis within the Limit of Age.
100 to 200	In 1000 . . . . 4.9
200 " 300	1000 . . . . 3.3
300 " 400	1000 . . . . 3.2
400 " 500	1000 . . . . 3.5
550 " 650	1000 . . . . 3.3

Merbach concludes as follows: "There is certainly nothing shown here of any marked influence due to the elevation of the various localities, or of such an influence as would cause the number of deaths from phthisis to decrease *pari passu* with the increase in elevation. A result of that sort was indeed not to be looked for, inasmuch as the several towns are subject to other influences—and some of them noxious ones, such as the occupation of the inhabitants, the density of the population—which are capable of neutralizing the effect of an elevated location. At the same time, even in instances before us, the good effects (otherwise sufficiently proved) of a high situation upon the prevalence of consumption can hardly be overlooked whenever we begin to compare the villages in lowest situation with those in the highest. . . . . The contrast comes out with special clearness when the averages calculated for towns situated at one and the same level are compared together."

Corval has worked out this relationship from the Baden bills of mortality over a period of four years (1869–72), including in his total, as he was bound to do, all those cases in which the cause of death was given as tuberculosis, "chronic pneumonia," or "phthisis." He distinguishes six groups of localities according to elevation:

Table of Mortality from Phthisis in Baden, according to Elevation.

Elevation in feet.	No. of towns or villages.	Population, average of four years.	Death from phthisis per 1000.
I. 330–1000	750	933,773	3.36
II. 1000–1500	337	224,210	2.75
III. 1500–2000	160	81,066	2.60
IV. 2000–2500	190	104,289	2.75
V. 2500–3000	97	59,155	2.33
VI. Above 3000	47	20,367	2.17

"In order to ascertain what effect is produced upon the death-rate from phthisis by density of population, industrial pursuits, and other things peculiar to towns, we may make a calculation of the mortality according to the size of every town or village in Baden, using Corval's figures: we shall find, accordingly, that it is 3.12 per 1000 inhabitants for the whole of Baden, 3.00 for villages of 3000 and under, and 3.49 for towns from 3000 to 10,000, and 4.56 for towns with more than 10,000 inhabitants. If, now, we arrange the places that are respectively over and under 3000 population in two columns, classifying them in six groups according to elevation, we shall get the following table of the death-rate from phthisis:

Altitude-Groups.	Under 3000 Population.	Over 3000 Population.
I.	3.11	4.05
II.	2.73	3.08
III.	2.49	4.99
IV.	2.71	4.72
V.	2.29	3.06
VI.	2.17	

In the series with less than 3000 inhabitants the favorable influence of increasing elevation is quite obvious, but in the second column of death-rates it will be seen that the benefit is in some circumstances more or less neutralized by detrimental factors belonging to the social and industrial life of the large centres or the towns. Still, from the facts, such as they are, we may adopt Corval's conclusion, that "cases of phthisis decrease with increasing elevation; or, in other words, in mere increase of altitude we may discover one of the most important factors in checking the development of consumption."

Müller's inquiries into the effect of elevation upon the prevalence of phthisis in Switzerland have led him to the same conclusion, although the results, as he is careful to explain, can be said to be only approximately correct, for the reason that the data at his service were not free from a good many omissions and errors. He distinguishes three groups of places: (1) Those in which from 43 to 63 per cent. of the inhabitants follow some industrial occupation (cantons of Outer Appen-

zell, Glarus, Neufchâtel, town and country divisions of Basel, and Geneva); (2) where the industrial part of the population reaches from 31 to 43 per cent. (cantons of Zurich, St. Gall, Thurgau, Zug, Inner Appenzell, Aargau, Schaffhausen, Solothurn, Bern, Ticino); and (3) the agricultural cantons, where the industrial population is only from 13 to 26 per cent. of the whole (Lucerne, Schwyz, Unterwalden, Vaud, Freiburg, Grisons, Uri, Vallais). Grouping the places in each of these divisions according to their elevation within a limit of 200 to 1800 metres (650 to 6000 feet), we get the following table of death-rates:

Table of Death-rates from Phthisis in Swiss Towns and Villages.

Elevation (in metres).	Industrial Cantons.	Mixed Cantons.	Agricultural Cantons.	Average.
200–500	2.7	1.85	1.4	2.15
500–700	3.0	4.55	1.2	1.9
700–900	1.35	1.7	0.7	1.0
900–1100	1.5	1.9	1.9	1.2
1100–1300	2.3	2.3	0.7	1.9
1300–1500	. .	1.4	0.6	0.8
1500–1800	. .	1.3	0.7	1.0
Average	2.55	1.7	1.1	1.86

Müller concludes from these facts "that in Switzerland consumption can be shown to decrease as we ascend; that the malady does occur, although rarely, at the highest inhabited spots; that the lowest localities have on the average about twice as many consumptives as the highest, and very much more than that if the cases where the phthisis had been acquired elsewhere be subtracted; that the decrease of phthisis with ascending elevation is, however, neither constant nor proportional; and that the irregularities and fluctuations which are noticeable are owing mostly to the position in the social scale, inasmuch as the industrial group of places show the irregularities most, and the mixed groups on the whole a regular decrease with height, while the agricultural groups touch their lowest death-rates at a comparatively small elevation.

"What the minimum elevation is that a locality must have before it feels the good effects of altitude on the prevalence of consumption is a question that cannot be answered with certainty from the facts before us. Gastoldi puts it at 600 to 1000 metres (2000 to 3300 feet); it seems to me, however, that a notable decrease in the disease can be shown to occur at as small an elevation as 400 or 500 metres (1500 feet), provided other circumstances are favorable. But any immunity from phthisis due to the height of the place does not come out decidedly until we go to elevations so great as to be uninhabitable in temperate climates like that of Europe. We must go to the equatorial parts of the world to study the sanitary effects of altitudes ranging

from 2000 to 3000 metres (6000 to 10,000 feet), and, inasmuch as the question is one of populous places and the seats of industry, we must take the large towns on the plateaus of the Andes in Central and South America, such as Puebla, with 80,000 inhabitants and at an elevation of 2300 metres or 7500 feet, Mexico (320,000 inhabitants, 7500 feet), Quito (60,000 inhabitants, 9300 feet), Bogota (40,000 inhabitants, 8500 feet), Chuquisaca (25,000 inhabitants, 9800 feet), Cochabamba (40,000 inhabitants, 11,000 feet) and Potosi (20,000 inhabitants, 13,000 feet). In all of these, which are to some extent industrial towns, or at any rate much occupied with trade and commerce, and by no means models of good sanitation, consumption, according to the unanimous testimony, is either rare, or, among the natives, it does not occur at all. And that is a proof that the influences which go with a very considerable altitude have the power to overcome those detrimental things that arise from a bad kind of hygiene and social life, in so far as these tend to produce consumption."

Opinions differ as to the nature of the influence of altitudes. Some trace it to the freedom of the air from decomposition-products, dust, and the like; others to the dryness of the air and soil; both of which opinions seem to me to be overthrown by the facts given above, as well as by the circumstance that the immunity from consumption occurs equally on dry and on damp plains, or in mountain-valleys abounding in lakes and pools, provided only that they stand at a considerable elevation. The only explanation that I can offer, and one to which I shall hold until something more satisfactory presents itself, is that people who have been born and brought up at great elevations have been always under the necessity of making frequent (or perhaps deep) inspirations as a consequence of breathing a rarefied atmosphere—that they are continually practising a kind of pulmonary gymnastics, from which there proceeds a vigorous development of the breathing organs and a greater power of resistance on their part to noxious influences from without. "After looking at the bustle of traffic in towns like Bogota, Micuipampa, Potosi, at elevations of 8000 to 12,000 feet," says Boussaingault; "after witnessing the strength and marvellous skill of the toreadors in the bull-fights at Quito, 9000 feet above the sea-level; after seeing young and delicate girls dancing a whole night at places almost as high as Mont Blanc, on which the celebrated Saussure had hardly strength enough to use his instruments of observation, and his hardy guides fell down in a swoon as they proceeded to dig a hole in the snow; when we remember, finally, that a famous battle of Pichincha was won almost in the altitude of Monte Rosa,—I think that you will agree with me that man can become adapted to breathing the rarefied air of the very highest mountains." I will readily grant that many of the accounts of embarrassed breathing experienced by natives

of the plains on ascending very high mountains are exaggerated; and I must confess that in my own case, after resting for a short time at elevations of ten thousand feet and upward, I was conscious of no considerable want of breath, or did not become aware, at least, of any need for quicker and deeper inspirations. At the same time, it is not to be denied that the atmosphere at elevations of ten thousand feet, especially in a warm climate, is rarefied to the extent of more than one-third of its volume at the sea-level. The quantity of oxygen contained in it is therefore considerably diminished, and a man must take in a larger quantity of air in a given time, or must inspire oftener than on the plains, so as to cover his requirements for oxygen. To that assumption no well-grounded objection can be raised, whether from the side of physics or of physiology; and there is equally little reason why we should not assume that those who have been born and have lived all their lives under such circumstances will have had their breathing organs powerfully developed. I do not hesitate, therefore, to believe that the reason of the immunity from phthisis enjoyed by the residents of elevated places is the influence which a continuous residence in a rarefied atmosphere exercises over them.

"On the other side, we may thus further explain the exemption from phthisis of many parts of the world by reason of their favorable weather-conditions and the consequent rarity of all pulmonary affections therein. The immunity from consumption enjoyed by natives of elevated regions seems to me to be referable to a peculiarly strong development of their breathing organs, and a corresponding power of resistance in them to noxious influences from without; it is proved that this is now not at all an affair of 'purity of the atmosphere,' as some have supposed, by the fact that the state of hygiene in the towns of Ecuador, Bolivia, and Peru, situated at great elevations, is by no means distinguished for its excellence, for cleanliness in the houses or streets, adequate ventilation of the rooms, and the like."

There is little to be added to this exhaustive and masterly array of facts and reasons setting forth the inhibitory influence of altitude upon phthisis. In Colorado, to which my personal observations upon the influence of the altitude have been mostly confined, the native population is too small and youthful to gather any statistics, but living as I have done for the past sixteen years among a people of whom perhaps 30 per cent. came to the country with tuberculosis, and not a few of whom live under unhygienic conditions in crowded lodgings, and where free expectoration is carelessly practised, I know of only four cases of phthisis which could be fairly assumed to have originated in Colorado. Let us now see what is known of the influence of altitude upon phthisis, when developed, as compared with the effect of other climates.

Comparative Results of the Treatment of Phthisis by Climate.

I have collected together for comparison in the tables which are appended the broad results of all reports I have been able to obtain, and they are, I think, sufficient to show the general trend of the climatic influences brought to bear upon the disease.

Table I. shows the results of treatment in low climates (less than 2500 feet above sea-level) in two groups—the first in open resorts, the second in closed resorts—that is, sanitariums; Table II. in elevated climates, above 4500 feet, all in open resorts. Each table gives the name of the reporter, the number of cases reported on in all stages, the percentage of cured, next of cured and improved combined under the heading "Benefited," then the percentage of those in the first stage, after which follows the percentage of cured and of cured and improved together, and finally the place where treated. Other details are purposely omitted, in order to bring out more clearly the general curve of the results. The total number of cases upon which the statistics are founded is as follows: Treated at low elevations in open resorts, 1809 cases; in sanitariums (also at low elevations), 2383 cases, making a total treated in low climates of 4192 cases, while a total of 790 cases were treated at an altitude. These tables, therefore, are based on a grand total of 4901 cases. Table III. gives a comparison from the combined percentages of the several groups.

By the terms "cured and improved" all observers mean that there has been a total absence of all symptoms, both local and general, for a reasonable interval of time, with general good health. In some instances, doubtless, sufficient time had not been allowed to elapse to prove the completeness of the cure. In spite of this, which occasionally makes the percentage too high, as a cure is something positive, the discrepancies between the observers must be much less in this than in the case of the improved class, the latter term being more indefinite, and necessarily embracing many whose future is uncertain, and probably also several in whom the results are not fully known, they not being traced up to date, while it is not likely that any would be placed in the cured class unless the observer's knowledge of their condition was positive and not merely inferred. However, if some of the improved class ultimately ranked with those who became worse, on the other hand few could also probably later be classed with the cured, and the proportion of each would undoubtedly be much the same relatively to the general average of cured and worse. The percentage of cured and improved of the total number of cases treated has a defect, when comparison is made between each group, on account of the variation in the extent of mischief in each case, no note being taken of the

amount, but only of the stage of the disease. However, when several groups are taken together, embracing a considerable number of cases, the tendency for the average proportion of those slightly and seriously affected to be about the same all the world over, no doubt largely mitigates this defect as far as comparison is concerned. Unfortunately, many of the reports do not give the results by stages, although here, again, there are, in addition to the differences in classifying under the heads cured and improved, as already referred to, the differences in the gravity of cases coming under the head of the first stage, as no note is made of the amount of the disease or the general health of the patient when first coming under treatment. However, taking together a large number of first-stage cases from various sources, the general law of averages comes in to modify this objection. In my experience the great difficulty in getting at the real truth of the results lies in tracing up the patients after they had left one's hands. In the case of the sanitariums the reports for the most part are made on patients treated up to the end of the year and reported on in a few weeks or months after its termination. Remembering how often relapses come, and how, to speak positively of the results, a case of phthisis must be followed for several years, I cannot but feel that the sanitarium reports, though doubtless true in their general tendency, are too optimistic, owing to the short space of time that the patients were under observation. I will now briefly refer to the special features of each report.

Reports of Low Climates, Open Resorts.—1. Dr. C. B. Williams, late of London, in his day one of the greatest authorities upon phthisis, and the father of the eminent Dr. C. Theodore Williams, reports 1000 cases. The elder Dr. Williams' cases were all taken from the wealthy classes, and therefore are in that sense selected; and this no doubt exerted a favorable influence upon the results through the patients' intelligence and ability to take care of themselves. They were otherwise selected only in so far as those alone were taken in whom the results could be verified. These 1000 cases, extending over twenty-two years, received the best climatic treatment of the day, exclusive of altitude. They sojourned in many parts of the world, though mostly in Europe.

2. The late Dr. Austin Flint of New York reports 670 cases, and he certainly enjoyed on this continent a reputation and opportunities in the treatment of phthisis equal to those of Dr. Williams in Europe. His studies of phthisis are some of the most valuable we possess, especially of its natural history. His cases were taken chiefly from the well-to-do class, though not as exclusively as Dr. Williams', and his patients did not use change of climate as extensively. His 670 cases extended over a period of thirty-two years, but they are not traced up as fully,

and the only statistics he gives is 44 cases of recovery. He implies that the recoveries—that is, the cures—were about 7 per cent. of the whole number where the results were known.

3. The Brompton Hospital for Diseases of the Chest reports 20 cases of phthisis which were sent out to the island of Madeira for the winter of 1865–66, and the results noted on their return to England: 2 are reported as improved, and 7 slightly so; none cured. These results were considered so discouraging that it practically prevented the sending of consumptives to such warm damp climates.

4. Dr. Hermann Weber of London, one of the first authorities on medical climatology, as has been mentioned in the section on warm, dry inland climates, reports on 24 cases which spent from one to four winters in Egypt; he does not state that any were cured, but 50 per cent. were improved.

5. Dr. D. H. Geddings of Aiken, S. C., reports on 69 cases who passed several winters in Aiken: how long a period they were under observation I do not know, but the fact that the results are so much more favorable than any others from low elevations or similar climates makes one think that the time may have been too short to make these figures reliable for close comparison. I do not know, either, how many were in the first stage.

6. Dr. H. A. Johnson, late of Chicago (6 cases). In the *Transactions* of the American Climatological Association for 1891 is published a paper by Dr. Johnson entitled "The Modification of Tuberculosis by Climate: Report of Cases," in which he reports upon 25 cases of pulmonary tuberculosis, 6 of whom spent more or less time in California and 19 in Colorado; the latter I have placed in the group for Elevated Climates. The 25, he writes, "embrace every case which during about three years, from 1872 to 1875, went to the Western States or Territories, and of which I was able to obtain any subsequent history. . . . . In this series there is not one later than 1875."

A short outline of each case is given, but the stage of the disease is not defined precisely; most of them, however, are easily grouped from the description. And those put as in the first and third stage are undoubtedly correct, while of those placed in the second some may belong to the first, none being so described but where signs of deposit are mentioned and when the statement that there is no cavity follows. I have concluded, since this is only made occasionally, that where it is done it is because there were some moist râles, showing softening had begun. The percentage of favorable results in the six cases is unusually high, but as I could obtain no other reports while recently visiting California, it is not possible to know whether these are average results or exceptionally good ones. Although the number

of cases is so small, the high reputation of the reporter makes them valuable.

The following are sanitarium reports:

7. The late Dr. H. Brehmer of Görbersdorf, whose magnificent institution is the parent of modern sanitariums for phthisis, reported in 1888 on 700 cases treated during the previous year (1887) with 13 per cent. cured, and 53 per cent. cured in the first stage. The climate is medium and slightly elevated.

8. Dr. Dettweiler of Falkenstein, a former resident of Brehmer's, and proprietor of an equally fine establishment, reported in 1888 on 1022 cases treated up to the end of the previous year, giving similar results. The climate and elevation are similar.

9. Dr. E. L. Trudeau of Saranac Lake reports on 146 cases treated in the sanitarium at Saranac Lake (elevation 1752 feet) in the Adirondacks, up to the end of 1888, the report being made in 1889. There was thus no margin of time to test results in the later cases.

10. Dr. Karl von Ruck of Asheville reports on 515 cases treated in his sanitarium up to the end of 1889, and which were reported in the following July, an interval of only six months after the last cases. The small proportion of first-stage cases is noticeable, and the percentage of cures among them is 50 less than Dr. Brehmer's. From what I can learn, however, the cases generally were worse off on admission.

Turning now to the results obtained in elevated climates, the only reports I could obtain were as follows:

11. Dr. Hermann Weber of London reported on 106 cases, nearly all of which were treated in the High Alps, with the results as shown in Table II. His patients were of a similar class to those of the Drs. Williams, and therefore in a sense selected.

12. Dr. Theodore Williams of London reported on 141 cases treated in the High Alps (with 4 exceptions, which were treated in Colorado and New Mexico and in the South African highlands). They were all of the wealthy class, and so far resembled Dr. Weber's selected cases.

13. Dr. Charles Denison of Denver reported on 202 cases treated in Colorado. He does not give any cures, but reports his best results under the head of "much improved." As this is 47 per cent., which is much above the percentage of cures by other observers, it is probable that many of these should be deducted to arrive at his proper percentage of cures; and he writes me that he estimates 10 per cent. should be deducted to give the approximate percentage of cures. I have therefore inserted this percentage, which, without being accurate, throws additional light on the general conclusions.

14. Dr. S. A. Fisk of Denver reported on 100 cases treated in Colorado. Unfortunately, he too does not report on cures, but also puts his best results under the head of "much improved;" and this reaches the still higher figure of 50 per cent. From what he informs me, I judge that his actual percentage of cures was about 15 per cent. less than this, and for the purposes of comparison I have so recorded it.

The author of this article at the meeting of the American Climatological Association held in Denver, September, 1890, reported on 141 cases of phthisis which he had treated in Colorado during the previous sixteen years. The first visits were paid between January 1, 1875, and January 1, 1888, leaving in no instance an interval of less than twenty months, and in all but a few from two to fourteen years had elapsed before the report was made. The results were all carefully traced up to date, and this with the interval of time indicated justified him in believing the results to be very near the exact truth. The cases were not selected, except so far as only those were taken in whom the results could be verified at or near the time of making the report. These were placed in the tables in the order as obtained, and when the desired number of 141 was reached no further search was made. This number was taken, and the particular system of reporting followed, in order to make an easy comparison of the results obtained by him in Colorado with those of Dr. Theodore Williams in the Alps. The author's report, though not giving the results of all cases treated, gives a fair sample of them. The results resemble those of the other reporters of altitude treatment, though not as good in results at most points. Dr. E. T. Williams' percentages are all higher. This I believe to be due mainly to three causes, the first being the greater proportion of first-stage cases —64.53 as against 43.37; second, the better material both as regards the personal equation and the existence of complications; and third, the shorter previous duration of illness, as shown in the original records. With respect to the personal equation, Dr. Williams' patients were all well-to-do Englishmen, who all could, and most would, take care of themselves, while mine were from all sorts and conditions of men. Apart from their circumstances, however, my experience in practice, both in London and at Colorado Springs, convinces me that whatever are their relative merits in other respects, the English make much better patients than the Americans. The third cause, being the longer interval of time before the report was made, accounts for the less favorable results in my reports. Space will not permit me to pursue the analysis further. I may mention, however, that in my original report I submitted abstracts of the case of each of the 141 patients in accordance with the plan of Dr. Williams, and they are published in the *Transactions* of the American Climatological Association for 1890.

Results of Climatic Treatment of Phthisis.

TABLE I.

In Low Climates (less than 2500 feet).

Reported by—	Open Resorts.						Where Treated.
	All Stages.			*First Stage.*			
	No. of Cases.	P. C. Cured.	P. C. Benefited.[1]	P. C. 1st Stage.	P. C. Cured.	P. C. Benefited.	
Dr. C. J. B. Williams . .	1000	3½	44½	67.	5.	45.	Various low climates.
Austin Flint	670	7.	. . .	. . .	. . .	. .	Various low climates.
Brompton Hospital . . .	20	. . .	45.	. . .	. . .	. . .	Madeira one winter.
Dr. Hermann Weber . .	24	. . .	50.	41½	. . .	67.	Egypt one to four winters.
Dr. W. H. Geddings . . .	69	19.	61.	. . .	. . .	. . .	Aiken, S. C., during winters.
Dr. H. A. Johnson . . .	6	50.[2]	67.	66½	50.	75.	California.
			Sanitariums.				
Dr. H. Brehmer	700	13.	. . .	. . .	53.	. . .	Görbersdorf during 1887.
Dr. P. Dettweiler	1022	13½	23.	. . .	. . .	. . .	Falkenstein up to 1887.
Dr. E. L. Trudeau . . .	146	11.	54.	. . .	. . .	. . .	Saranac up to 1888.
Karl von Ruck	515	11½	. . .	15.	24.	45.	Asheville up to 1890.

[1] "Benefited" includes the cured given in the column preceding and all others whose condition was on the whole improved.

[2] It will be noticed that these percentages are much higher than the others in the table, suggesting that, owing to the small number of the cases, some accident in result has had undue weight.

TABLE II.

In Elevated Climates (4500 feet and upward).

Reported by—	Open Resorts.						Where Treated.
	All Stages.			*First Stage.*			
	No. of Cases.	P. C. Cured.	P. C. Benefited.	P. C. 1st Stage.	P. C. Cured.	P. C. Benefited.	
Dr. Hermann Weber . .	106	36.	75.	66.	51½	64.	Alps.
Dr. Theodore Williams .	141	41.	75.	65.	63.	90.	Alps.
Dr. H. A. Johnson . . .	19	37.	79.	47.	44½	78.	Colorado.
Dr. Charles Denison . .	202	37.[1]	80.	37.	75.	92.	Colorado.
Dr. S. A. Fisk	100	35.[2]	67.	42.	66.	91.	Colorado.
Dr. S. E. Solly	141	35½	67½	44.	58.	87.	Colorado.

[1] Dr. Johnson's 19 cases all went to Colorado, except one to Western Kansas, the climate in the latter place being like that of Colorado, as the average elevation is 3500 feet.

[2] Denison in his original reports did not give any as cured, but 47 per cent. much improved. He estimates, however, that a deduction of 10 per cent. from this would give the approximate number of cured. The same deduction is made in the first-stage cases, changing "85 per cent. much improved" into 75 per cent., as shown in this table.

[3] Fisk, like Denison, in his original report did not give any as cured, but gave 50 per cent. much improved. From a recent communication that I have had with him, if 15 per cent. be deducted from this it will probably give nearly the number of cures; and this applies to the first-stage cases also, where he gave 81 per cent. as much improved.

TABLE III.

[1] *Comparison between Open Resorts and Sanitariums in Low Climates.*

	All Stages.			First Stage.		
	No. of Cases.	Cured.	Bene-fited.	No. of Cases.	Cured.	Bene-fited.
Open resorts in low climates . . .	1724	6 p. c.	46 p. c.	625[2]	5 p. c.	45 p. c.
Sanitariums in low climates . . .	2443	13 "	27½[3] "	89	31½ "	45 "

[1] The number of cases in each report has been added together and divided by the number cured or benefited under the different heads, and the percentage arrived at in this way (and not by adding the percentages together and dividing by the number of reports); where the reports omit the number of cured, benefited, or in the first stage, this particular total number of cases is not taken. Thus these percentages represent the percentage of the total number of cases reported under the several heads.

[2] As shown in Table I., only three of the observers give the number benefited in the first stage, and only two the number cured. For this reason no reliance can be placed on the next figure, "5 per cent. cured," as being the true percentage of the total cases, and it is obviously lower than is the real percentage.

[3] That the total number benefited in sanitariums is actually less than in open resorts, as is shown here, is difficult to believe; yet Dr. C. B. Williams reported 44½ per cent. of his 1000 cases treated in open resorts as benefited, while Dr. Dettweiler reported only 23 per cent. benefited out of the same number treated in his sanitarium. This suggests that there may be a considerable difference between them in the use of the term "improved." The only other of the sanitarium reports from which the benefited could be obtained was Dr. Trudeau's, in whose 146 cases 54 per cent. were benefited; but even this percentage is exceeded by Drs. Geddings and Johnson in open resorts, and nearly equalled by Dr. Weber, though the total number of cases reported by these three observers is less than a hundred, while Dr. Dettweiler's are over a thousand.

TABLE IV.

Comparison between High and Low Climates.

All Stages.			First Stage.		
LOW CLIMATES.[1]					
No. of Cases.	Cured.	Benefited.	No. of Cases.	Cured.	Benefited.
4167	10 p. c.	36 p. c.	714	20 p. c.	44 p. c.
HIGH CLIMATES.					
709	36½[2] "	74 "	350	62 "	84½ "

[1] These percentages are obtained by taking all the totals in the reports from low climates, both of open resorts and sanitaria, and treating them in the same way as in Table III.

[2] It will be observed that the percentage of cured in high climates is, relatively to low climates, higher in all stages than in the first stage alone. Why this should be so is not easy to explain. It would be probably expected that it would be relatively higher among the first-stage cases than among those at all stages. But, as is shown, there are 3½ per cent. more cured in high climates than in low, taking all stages together; while taking the first-stage cases alone there are but 3 per cent. more. This may be explained by the fact that, leaving out the first-stage cases and taking the second and third stages together and comparing them, we find that there are 3½ per cent. more cases cured in high than in low climates (the percentages being 3½ per cent. in low and 12 per cent. in high). This shows that, although absolutely there are more first-stage cases cured at an altitude, yet there are relatively ½ per cent. more of the advanced than of the early cases cured. Quite a number of the first-stage cases (of limited disease) will, as we know, get well under even the most unfavorable climatic and hygienic conditions, whereas it is a rare thing to hear of the cure of those markedly affected in whom softening has commenced under any but the most favorable conditions; and even then, as these tables show, the number is only 3½ per cent., except in high climates, where it is 12 per cent.

Can patients cured at an altitude return to low climates? To answer this question I will quote from my paper on the "Results of Treatment of Pulmonary Consumption in Colorado:" "Of the 141

patients, 59—that is, 41.84 per cent.—left Colorado. Of these, 45—that is, 61.44 per cent.—are to-day in the improved class, as they were on leaving, while 38.31 per cent. were worse on leaving or became so since. Of the 59 who left, 33 had been in the first stage, 26 in the second or third. Of the 82 who remained (58.15 per cent. of the whole number), 82.76 per cent. are in the improved class, while only 17.24 per cent. are worse. This indicates that several of those who went away might have been improved by a longer or permanent residence. On the other hand, of those who remained and improved there are undoubtedly several who are well enough to leave (but prefer to remain), 19 being permanently cured; and from my knowledge of their condition I believe it fair to assume that about 50 per cent. of the total number coming to Colorado can return to their homes to live in safety, providing of course the danger to them in returning home is only climatic. The percentage of improvement and the number of those who could have returned permanently to their homes would have assuredly been very much greater had several more exercised forbearance in delaying their return until the disease was more decidedly arrested. I am firmly of the belief that cases cured in elevated countries have at least as good a chance of keeping well after returning home as those cured at sea-level, and, owing to the decided increase of general and pulmonary vitality imparted by the climate, probably a much better one." These opinions coincide with those expressed by the other observers of altitude treatment.

General Conclusions.—The reports, which are all that could be gathered, are from sixteen different sources, reported on by the best-known observers in Europe and America, based on a total of nearly five thousand cases. The climates in which the cases were treated were various and widely scattered, so that the influence of every kind of climate is here represented. The deficiencies in some of the reports undoubtedly prevent a fair comparison at certain points, and in the reports where the number of cases is few the results are naturally sometimes too high or too low. The care or opportunities in following up the cases of course varied much with the different observers, as well as their degree of conservatism in making statements and their views as to the exact meaning of the terms "cured" and "improved." Therefore a close comparison between each of the several sets of observations cannot be made. When, however, we group them together, the law of averages comes in and the optimism of some observers is balanced by the conservatism of others.

The general truth of the reported results, however, is shown by the close resemblance of the figures in the different groups. Especially is this the case in the three chief divisions made—namely, of reports of cases treated, first in open resorts in low climates; second, in sanita-

riums in low climates; third, in low climates, both in open and closed resorts (sanitariums) combined; and fourth, in open resorts. Again, the differences in the quality of the cases prevents close comparison between them.

Gross Results.—In contrasting those treated in open and closed resorts in low climates, we find that twice as many were cured in closed as in open resorts in all stages, while in the first stage there were probably more even than this, but the figures under this head for open resorts are too scanty to make a fair comparison, while the total benefited is about the same, being even higher at all stages in open resorts. Whether this is due to a different use of the somewhat elastic term "improved" or some other accidental cause I do not know, but it seems somewhat out of harmony with the general tendency of the figures. Taking the results from all treated in low climates compared with all treated in high climates, we find that three and a half as many were cured in high climates as in low in all stages, and in the first alone three times as many, while both in all stages and in the first stage alone only twice the number were benefited. Comparing those treated in low climates in closed resorts with those treated in high climates in open resorts, the difference in cures is not as great, being about twice instead of three times as many.

The final conclusion is, that a consumptive treated in an open resort in an elevated climate has three times as good a chance of recovery as has one treated in an open resort in a low climate, and twice as good a chance as one treated in a sanitarium in a low climate.[1] Though in prescribing a particular resort for a given case of consumption the decision is dependent on many minor points that are elsewhere referred to, yet the broad truth remains that of all factors, climatic or otherwise, in the treatment as well as in the prevention of phthisis, altitude is by far the most powerful of them all.

Indications and Contraindications for Altitude Treatment.

Dr. F. I. Knight of Boston, who has probably made use of altitude in the treatment of phthisis more extensively than any other physician on this continent, and has shown especial care and discretion in the selection of his cases, in the *Transactions* of the American Climatological Association for 1888 published a paper entitled "Indications and Contraindications for Altitude in the Treatment of Pulmonary Tuberculosis," of which I make the following abstract: 1. He limits the

[1] The treatment in sanitariums in high climates is too recent to furnish any reliable statistics as yet, though my observations in the Bellevue at Colorado Springs lead me to believe that the same relative improvement between cases treated in open and closed resorts in low climates that is shown in these tables can be demonstrated in high climates also.

age of those using altitude to fifty years. In temperament he prefers the phlegmatic to the nervous with an irritable heart, frequent pulse, and inability to resist cold; and with the latter, he says, we must not compare those who show nervous irritability from disease, not temperament, as they are generally benefited in high places. As regards disease, he first considers cases of early apical affection with little constitutional disturbance, and although these generally do well under most conditions, yet considerable experience assures him that more recover in high altitudes than elsewhere.

2. "Patients with more advanced disease, showing some consolidation, but no excavation nor any serious disturbanee." When both the apiees or much of one lung is involved, and the pulse and temperature are both commonly over 100, it is best to begin with a low altitude.

3. Hæmorrhagic cases, early cases with hæmoptysis and without much fever or much disease, are benefited by high altitudes.

4. Patients with advanced disease, those with cavities or severe hectic symptoms, should not be sent to high altitudes. A small quiet cavity is not a contraindication; hectic symptoms are contraindieations.

5. Patients in an acute condition should not be sent.

6. Cases of fibroid phthisis are not suitable.

7. Convalescents from pneumonia or pleurisy are usually well suited to elevated regions.

8. Advanced eases of tubercular laryngitis, if good local treatment and freedom from dust can be had, may do no worse than elsewhere.

9. In cases complicated by other diseases there is much care needed. Cardiac dilatation precludes high altitudes; so also does hypertrophy for the most part, though with exceptions. A cardiac murmur the result of endocarditis quite long ago, with no signs of enlargement or deranged circulation, should not prevent. Nervous derangements of the heart are usually contraindications. In renal disease and in chronic hepatitis the local physicians claim that benefit is often obtained. Intestinal ulceration is not barred out, but benefit is doubtful. Heredity to phthisis is no bar to high altitudes, but diabetes render them objectionable. Syphilis is no contraindication, though in phthisis the combination always makes the prognosis bad.

I will here finish this branch of our subject with an extract from a paper I read before the American Climatological Association, September, 1889, entitled, "Invalids Suited for Colorado Springs:" "The most marked benefit is shown in antagonizing and arresting tuberculosis in those whose ancestry or physique, or both, convey the impression of their being affected with a tendency to a general tuberculosis. Hæmorrhagic cases are found to do well. Phthisis consequent upon croupous pneumonia or pleurisy is generally benefited. The presence of a

cavity is not, in itself, a bar to receiving benefit. Fibroid phthisis is usually improved. Cases of so-called catarrhal pneumonia generally do well, but if there is a marked tendency to acute febrile catarrh of the tubes or a specially irritable and useless cough, a more medium climate is indicated. Rapid progress and pyrexia are not contraindications if there is evidence of a sufficiency of healthy lung remaining, and if the patient is able to take and assimilate enough food, and shows a fair power of reacting to stimulation by cold and a capacity toward recuperation from fatigue. Very moderate dilatation of the heart in the young is not a positive contraindication if care is exercised, nor is old valvular disease if tolerated and compensated for. Albuminuria caused by lardaceous disease would be a decided contraindication. Any renal complication of phthisis makes the experiment of change to Colorado of extremely doubtful advantage, though chronic Bright's disease, without pulmonary disease, is usually favorably influenced. Chronic catarrh and inflammation of the throat, nose, or bronchi are generally improved, and even tubercular laryngitis is, *per se*, not a contraindication.

"To sum up as regards the individual, the anæmic and phlegmatic are best influenced; as regards the disease, the chronic, the first as regards the stage of the disease. A larger margin of sound tissue in the peccant organ is demanded than in changing to a less extreme climate, and a certain evidence of vital resiliency is imperative. With respect to pulmonary disease, let it be especially remembered that in sending your patients to Colorado you are putting them, as it were, in a gymnasium, and they will need prudence and instruction to benefit by it; that the whole principle of the influence of altitude upon chronic disease is the exciting of a healthy life in the place of an unhealthy, and that in the process there comes the strain of the battle; that in prescribing an altitude, to ensure success, as in prescribing the most powerful remedies of the Pharmacopœia, the method of administration demands our most careful consideration."

Cases of Phthisis Suited for Altitude Treatment.—The next best climate for most of these is undoubtedly a low, dry one: when, however, there is much irritability of the nervous system, the heart, or mucous membranes, a warm, not hot, climate, with medium dampness, is desirable for its sedative effect and through allowing much outdoor life. There are also climates where a partial effect of altitude is obtained at elevations between 2000 and 3000 feet. Dr. G. A. Evans, in his excellent *Handbook of Phthisiology*,[1] gives the following classification of the climates resorted to by consumptives in the United States, which may be found of service in making a choice

[1] *Handbook of Phthisiology*, G. A. Evans, D. Appleton & Co., New York.

for a particular case, provided the governing principles have been previously grasped:

1. *Climate Cool and Moderately Moist.*—General elevation 2000 feet, western slope of the Appalachian chain, Adirondack, Catskill, Alleghany, and Cumberland mountains. 2. *Climate Moderately Warm and Moderately Moist.*—Between North Carolina, Asheville, elevation 2250 feet; Western South Carolina, Aiken, Georgia, Marietta, and Thomasville. 3. *Climate Warm and Moist.*—Florida (equable), Southern California, coast region (equable). 4. *Climate Warm and Moderately Dry.*—Elevation about 2000 feet, South-western Texas, Southern California, inland. 5. *Climate Cool and Moderately Dry.*—Elevation about 1000 feet, Minnesota, Nebraska, Dakota. 8. *Climate Cool and Dry.*—Elevation from 4000 to 7000 feet, Montana, Wyoming, Colorado, Northern New Mexico, and Western Kansas. 7. *Climate Warm and Dry.*—Elevation 3000 to 5000 feet, Southern New Mexico and Southern Arizona.

Affections of the Respiratory Tract other than Phthisis.

Convalescence from croupous or catarrhal pneumonia, when the patient is still weak and unable to exercise, is usually best hastened by a warm equable climate, in which time can be passed in lying in the open air; when, however, the clearing up of the affected portion of the lung is delayed, and yet the patient has recovered a sufficient amount of vigor to allow him to walk about and keep his blood in healthy circulation, an elevated climate will generally ensure more complete and rapid recovery, and the cool air, being dry, will prove especially beneficial.

Delayed recovery from pleurisy is generally best treated at an altitude. Convalescence from acute bronchitis is usually completed most satisfactorily in a warm low climate, as also is chronic bronchitis; if the latter proves intractable, it has usually tuberculosis behind it, in which case an altitude should be tried, unless age, emphysema, or heart complications forbid it; then a warm, dry inland climate of moderate elevation is best.

Asthma, when the neurotic element is the prominent symptom, is nearly always relieved most effectually in high elevations, and sometimes cured. When the asthma is evidently dependent upon or overshadowed by cardiac or bronchial complications, medium climates are best, the question of reflex irritation, nasal or otherwise, being first attended to.

Dr. C. Denison in his address as president of the American Climatological Association, September, 1890, reports on 52 cases of asthma treated in Colorado: 72.5 per cent. were more or less improved. All of the cases that got worse, and all but one of the stationary, had

more or less marked emphysema. This agrees with my own observation, that when there is marked emphysema resort to an altitude is useless, and often dangerous.

Chronic Laryngitis.—When tubercular, I am firmly convinced that treatment in an elevated climate is more apt to mitigate, and occasionally to cure, this usually hopeless disease than when administered in a low climate. My statistics, published in the *Transactions* of the American Climatological Association for 1890, show this. In chronic laryngitis, non-tuberculous, the climate must be fitted to the case upon general principles, and such questions asked, Does the disease improve most under sedative or stimulating treatment? Is the patient better in damp or dry weather? etc. The same rule applies to catarrh and chronic inflammation of the pharyngeal and nasal tracts.

Diseases of the Heart and Great Vessels.

As this subject has been mentioned before in connection with sea climates, I will here refer only to the influences of elevated climates, and thus, by placing before the reader the effects of the two extremes of climatic change, give the guiding principles for selecting a climate for a particular case.

It is a matter of universal observation in Colorado that the heartbeats are at first increased, and that in those with whom the climate agrees, and in whom there is no pathological condition preventing it, the heart-beat will return in time to its usual rate, the time being longer or shorter according to the general vigor and age of the individual. That one of the secondary effects is to make each cardiac contraction stronger is, I believe, true. The direct impression gained from observations by ear and finger on the relative strength of the contractions agrees with this. Pathological observation, however, is the best evidence. A considerable number of anæmic consumptives, especially when young, have a tendency, more or less developed, toward simple dilatation. Many cases which gives no signs at sea-level exhibit them on first coming to Colorado. Such cases, if permitted to exercise only with great care, generally gradually lose all symptoms of dilatation, and some in time show signs of hypertrophic compensation, if improvement in general health occurs, and if, of course, the cardiac muscle has not been stretched too far or is not degenerated, so as to prevent it from regaining its elasticity. The observations of Oertel confirm this view. Moderate dilatation in persons under thirty years, who otherwise the climate benefits, is often improved if they will submit to very strict medical discipline, especially in the matter of exercise; but practically such cases can usually be treated successfully in other places with much less risk than they encounter at this elevation. Graduated gymnastic exercises and climbing steps and moderate hills

can, I believe, be better used to strengthen the cardiac muscle than putting them under the continuous strain that living at an altitude of 6000 feet involves. Where the dilatation is marked the exercise at this elevation is necessarily so limited that the patient is apt to chafe under the restriction and break it to his own detriment, or suffer in general health for want of sufficient exercise to promote appetite and nutrition.

It is hardly necessary to say that all cases in which there is fatty degeneration of the heart, or in which there is evidence of grave valvular lesion without ample compensation, should not be exposed to the dangerous strain that the first effects of the climate involve. Cases are seen in Colorado who have passed through this period, and who, living a careful life, do comparatively well. No doubt in such cases it is because the secondary and chronic climatic effect is to equalize the blood-pressure throughout the entire vascular system and make the circulation vigorous and complete. All the finest capillaries being well filled, the continued effect is to relieve strain in all parts and to get rid of chronic local congestions. The most powerful proof that the foregoing statements are true is the fact that has been established by Archibald Smith, from his experience in the Andes, of a marked mitigation of the symptoms in cases of aortic aneurism; and this the observations of myself and my colleagues fully confirm. Nevertheless, in view of the great danger of permanent increase, during the early portion of the stay, or by sudden or violent exercise during any later period, it cannot be wise for the physicians to recommend such cases to come to this elevation. Were the American patient, like the German, more dependent upon the judgment of his physician, this advice would doubtless admit of modification; but, alas for the procuring of the best results of treatment, our patients have yet to learn that in many diseases the autocratic regulation of their daily exercise is the most valuable aid that medical skill can offer them. The decided effects of the altitude in exciting and disturbing the action of the heart in sensitive persons, even without disease, is shown by many who, after living comfortably for several years at this elevation, 6000 feet, ascend to the summit of Pike's Peak, 8000 feet higher. These persons, while there, except for a feeling of lightheadedness, are all right as long as they do not attempt to walk, when even a few steps taken will bring on rapid and often irregular beating of the heart, generally slight headaches, and often nausea and diarrhœa, and, in some, slight præcordial pain, the headache and pain over the heart often persisting more or less for twenty-four hours after their descent. Cases of valvular lesions in which there are no secondary complications, and there are exhibited accommodation and tolerance both local and constitutional to the impaired working of the organ

while the patient is prudent, are decidedly benefited by the tonic effects of altitude.

With respect to nervous affections of the heart the question of climatic influence must be approached from the nervous and not the cardiac side of the subject. Cases of anæmia and chlorosis are invariably relieved by the Colorado climate.

In choosing the climate for a patient with cardiac disease, apart from the question of atmospheric pressure here referred to, the promotion of the general health, and especially of encouraging the activity of the skin and kidneys, has to be considered, with a view of relieving the strain upon the circulation.

Diseases of the Nervous System.

Where organic lesions are progressing a sedative climate, such as a warm, sheltered sea-shore, is certainly the best. In chronic organic disease of long standing, with fair general health, a dry cold climate or a high elevated one may be cautiously tried when other climatic change has been unsuccessful; but age, atheroma, or cardiac complication would be decided contraindications. In cases of functional disease the turning toward sea or mountain is influenced by the question of whether a sedative or stimulant is called for. The former is the more suitable where there is much nervous irritability with a good circulation, and the latter when it is accompanied with a feeble pulse and cold extremities. The same also holds good when there is nervous depression, mental or general. With respect to the influence of altitude upon nervous diseases, Dr. F. T. Eskridge of Denver read a valuable paper before the Climatological Association, September, 1890, and I reported on cases treated in Colorado to the Colorado State Medical Society, 1879; both of which support the foregoing conclusions.

Neurasthenia.—One of the most serious symptoms of this disorder is usually insomnia, and the climate which best relieves this is the one in which the greatest general benefit will be found. As showing the effect of altitude upon neurasthenia, I will quote five cases treated in Colorado which I reported some years ago. The conclusions drawn from them have been confirmed by more recent clinical experience.[1]

In judging of the effect of the climate it is necessary to separate the improvement that is specially due to the particular locality from that which is due to the influences common to any place where the patient enjoys fresh air, sunshine, and relaxation from strain and worry. This separation can only be effected satisfactorily when the patient has tried other climates for the same symptoms. In five cases

[1] "Influence of the Climate of Colorado upon the Nervous System," by S. E. Solly, *Colorado State Medical Society Transactions*, 1879.

of which I have notes the patients had tried other climates. The outlines of these I will briefly give:

CASE 1. D. B——, aged thirty-four years, secretary to a railroad company, enjoyed good health up to 1870, when he began to be much worried and overworked; went to Europe in consequence of breaking down with the following symptoms: Insomnia; forehead-ache; irritability of temper, with depression of spirits; inability to fix his attention on writing or reading for more than a few minutes at a time; rheumatic pain in the calves of both legs, increased by walking; frequent perspiration, then "pins and needles" in legs; later, tingling in arms, then forearms and hands, preceded by what he called a "nervous grip," beginning in the neck and passing around to the jaws; at the same time some want of control over the bowels, not over bladder; cardiac palpitation; digestion easily upset; some tremor and no vertigo. He travelled in Europe for a year, then returned home with all the symptoms abated and in good general health, but not entirely recovered, as proved by inability to do much work for some time; then got into fair health, worked hard, and in March, 1876, same symptoms began to come back, and in October, 1876, he came to Colorado Springs, at that time much worse than in the first attack. Did not see much change on first coming, except that he slept better. Came under my care on October 27th. He was treated with tonics, a diet for trouble of bowels, moderate exercise, and bromide of potassium when required. He had some nervous attacks, brought on by unusual exercise or excitement, when he felt worse than he did when at home or in Europe; they quickly passed off, and in the main his improvement was steady, until, at the end of January, 1877, all his symptoms had disappeared, and he was able to apply himself for several hours to reading or writing without feeling any bad effects. By my advice he then left Colorado for a trip through the South with friends. He continued to gain strength, and resumed his official duties in the following May, and was married in the fall. I have heard from him recently as being perfectly well and equal to any ordinary work. In this case a residence of four months in Colorado did more for him than a year's trip in Europe.

CASE 2. H. H——, lawyer; aged forty-eight years; had previously enjoyed good health, and had worked hard for twenty years at his profession. In 1870 he broke down, with violent headaches, especially at the back of head and neck, insomnia, slight vertigo, nervousness, inability to concentrate his mind, and there was present phosphatic urine. He now took a sea-voyage, and travelled in China and elsewhere for more than a year. He partly recovered, though he was not so strong as before; and he did not improve at all till the last few months of his holiday. The same symptoms returned in May, 1877, and continued

to increase until he was obliged to give up work and come to Colorado for a rest, which he did on July 16, 1877. He said he was not quite as bad as when he went away eight years before, but he felt he would soon be so if he continued working. Except for sleeping better, he did not feel any relief till he had been in Colorado about a week, when he began to pick up. He remained at Manitou a short time, when, excepting for regulating his bowels, no treatment was carried out; he then made a fishing and shooting excursion of two months' duration through the mountains, at the end of which his symptoms had vanished, and he said he felt equal to work again, and returned home to resume work in a modified form. In this case the symptoms were not so advanced as when he took his sea-voyage, yet the effect of the change of air was much more striking and rapid in Colorado.

Case 3. F. G——, aged forty-two; engaged in an extensive business; has worked hard all his life in his office; always dyspeptic; dyspepsia became worse in December, 1876, and to it were added certain nervous symptoms—headache, insomnia, and nervousness, differing from those arising previously from dyspepsia. He arrived at Manitou August 10, 1877, and continued the same treatment as before for the dyspepsia. He lived most of the time out of doors, and returned home in five weeks with nervous symptoms entirely removed and dyspepsia much improved. He wrote me last month from Pau, in the south of France, that, his trouble having returned during the winter, he had gone to Europe, and, though improved, did not find that he recovered as quickly as before, and believed Colorado was the best climate for him. In this case the dyspepsia was evidently dependent upon the nervous exhaustion.

Case 4. H——, aged forty-nine, merchant; had been tied down to his business for many years; had twice before been attacked with dull pain in back of head and neck, insomnia, languor, and nervousness. He had each time gone to Europe and returned well. He came to Colorado in April, 1878, with the same symptoms as before; and remained only three weeks, but his symptoms left him after he had been here a week.

Case 5. R. S——, aged forty-five, manufacturer; had always worked hard at his business; three years before had an attack of pain across forehead, with vertigo, and sore feeling in back of neck, some difficulty of vision, inability to concentrate thought, and insomnia. He went to the Atlantic seaboard for two months and the symptoms disappeared. After this he came to Colorado, October, 1877, with the same symptoms, and after a few days began to improve, and left in a month free from any trouble.

In these cases there was evidently no material change of structure or important complications.

Admitting the difficulty of comparing accurately the condition of these five cases during their early and later attacks, the last of which brought them to Colorado, they at least show that the fatigued brain and cord were not irritated, but soothed and rested in the pure mountain-air.

I regret that I cannot command for comparison any clinical reports of cases treated in ocean climates. I am, however, very strongly of the opinion, allowing the contraindications which have been suggested, that the larger proportion of cases of neurasthenia are most surely and quickly benefited by high climates. This opinion is formed from my observations in Colorado, and also in noticing the effect upon such patients who were sent from England to Alpine resorts. Where, however, there is but slight if any anæmia and much irritability, the sea-shore, or still better a sea-voyage, is more suitable. In choosing a climate for cases of chronic neuralgia or migraine the same general principles must guide us.

Epilepsy when not improved at the sea-shore is often benefited at an altitude, but it is always safer to try the more sedative climate first, and mere change will often make remedies of more avail in those cases which admit of improvement. Chorea is generally best treated in low climates.

Kidney Diseases.

Parkes demonstrates[1] that as the temperature of the air rises above 49 degrees the urea, chlorides, and other constituents of the urine decrease. In the Royal Society's *Transactions* for 1861 it is observed that the urea is lessened with severe cold, and Dr. Edward Smith's observations, made in England during an exceptionally cold year, proved that more urea is secreted in summer than in winter.

The British Government statistics and the observations of Dickinson, Morehead, Martin, Hyaltelin, and Chambers prove that renal disease is most common in temperate climates, and least so in cold ones, and, if the secondary or lardaceous cases are eliminated, rare in the tropics. The prevalence of the disorder in temperate climates may be explained, as Dickinson suggests, by the axiom that the liability of an organ to disease, particularly to inflammatory disease, bears a general proportion to its functional activity. The respiratory organs are more active in cold, the kidneys in temperate, the liver and bowels in hot, climates.

The statistics of the British army, taken for upward of eight years in all parts and all climates of the globe, confirm this by demonstrating that the prevalent diseases in Arctic climates are catarrhal affections of the respiratory tract; in temperate climates, tubercular and renal disorders; and within the tropics, dysentery, hepatitis, and malarial

[1] Parkes on *Urine*, p. 95.

fevers. Statistics show that a wide range of temperature with sudden changes increases renal disease; where the range is high, however, these variations do not increase the amount of the disease, but where it is low, it does so to a marked degree. Statistics also tend to exhibit the fact that dampness develops the disease, but as this element is so mixed with other factors, this point is not thoroughly demonstrated. It is, however, a matter of common observation, writes Dickinson,[1] that patients with albuminuria thrive better and prefer a dry bracing air to a damp relaxing one.

Dickinson further states that statistics prove that renal diseases chiefly abound where the mean annual temperature is not so far removed from fifty degrees, while in whatever direction we leave the temperate range we find albuminuria less common. In Iceland it is rare, and, going toward the warmer latitudes, excepting the lardaceous form, it diminishes as the temperature increases. He indicates further that with an equivalent temperature the dryer climate shows less kidney disease. Copland[2] enlarges upon the fact that the skin of the negro is a much greater and more elaborate apparatus for excretion than that of the natives of temperate and cold countries. In the white man, inhabiting the hot countries, he shows that the liver is larger and more active to supplement the comparatively deficient cutaneous action, while in temperate climates the kidneys more especially aid, and in cold climates the lungs still more.

All the observations referred to, however, dwell much upon the temperature and very little on the humidity, and this neglect of the consideration of humidity and temperature together is common to all but recent writers. Weber says: "The separation of water by the lungs and skin is diminished in great dampness and more work devolves upon the kidneys, while their activity is less called upon when the air is dry and warm; and we must always pay great attention to this in affections of the kidneys." He further writes: "As cold air contains less vapor than warm, therefore there is more loss of water by the lungs when the air is cold than warm." It is admitted that warm dry air relieves the kidneys by increasing the amount of water excreted by the skin, while the warmth, as opposed to the cold, rather decreases the excretion of water by the lungs. Why should not cold dry air also relieve the kidneys through the greater excretion of water by the lungs, compensating equally for the lessened excretion by the skin, and (as it has been shown that in the white races the lungs take more of the work of excretion upon themselves relatively than does the skin, and that in the body's economy the compensating power of an organ is

[1] *A Treatise on Albuminuria*, by W. H. Dickinson, M. D., W. Wood & Co., New York.

[2] "Climate," *Copland's Medical Dictionary*, Longmans, Brown & Green, London.

exerted, within reasonable limits, in proportion to its needs) it is rational to suppose that the increased activity of the lungs compensates exactly for the skin's deficiency, and that cold dry air relieves the kidneys as much as does warm dry air.

It must be admitted that theoretically a warm dry, equable climate is the ideal one to relieve the diseased kidneys at their work. But this is, as has been shown elsewhere, a combination of qualities which cannot exist in nature, for the reason that the dryer the climate the less the equability; with dryness comes relief to the kidneys by more evaporation from both lungs and skin; with dampness, on the other hand, less evaporation, but also less danger from changes of temperature; with warmth, more secretion from the skin and less from the lungs; and with cold, more from the lungs and less from the skin; with warmth, again, more prolonged outdoor life, and with cold more toning up of the general vitality. Thus whatever way we look we find that in one or other of the elements there is a falling short of the ideal standard of climate.

To pass from the theoretical to the practical consideration of the subject, beyond such opinions as I have quoted very little clinical evidence is furnished by the barren literature of this subject, and certainly nothing has been proven.

The Influence of Climate upon Bright's Disease.—As observations of the effect upon this disease of such an extreme climate as Colorado may tend to shed some light upon the probable influence of climates in which the conditions are more or less reversed, I will quote from a paper I wrote some seven years since:[1]

"During a general practice of nine years in Colorado Springs and Manitou, leaving out cases of lardaceous disease, I believe I have seen a smaller proportion of cases of Bright's disease than would be expected in most other localities.

"I remember but four cases of primary renal disease that I have treated, all of which came from the mountains. They arose from a great and sudden exposure. They were all relieved on being brought to this lower level, and, though seriously ill, all made good recoveries whilst here. It is usually believed that acute nephritis is not infrequent among miners and ranchmen in the mountains. Inquiries I made recently at Leadville from four physicians who had been in large practice there for several years by no means confirmed this opinion.

"Although I have examined the urine at some period during pregnancy in the majority of cases that have come under my care, I remember to have found albuminuria in a very few, and only in two were any further symptoms developed: one with slight œdema became

[1] "Bright's Disease of the Kidneys, as Influenced by the Climate of Colorado," by S. E. Solly, *Transactions Colorado State Medical Society*, 1884.

perfectly well after confinement; the second, with convulsions and abortion at seven months, had a mere trace of albumin and no casts, and no other symptoms two months after the miscarriage, when she left for the East.

"I have frequently examined the urine during convalescence from scarlatina, but only remember one case of Bright's disease in consequence of the fever. In this instance there had been exposure and neglect, and there was much dropsy. The case, however, made a good recovery, remaining in this climate. In practice in London previously I found albuminuria a common sequela of scarlatina. In our county society the opinion of my colleagues was that scarlatinal nephritis is decidedly rare in this district.

"Lardaceous disease of the kidney being systemic in origin, makes it impossible to separate the climatic influence upon the kidney from the antecedent disease, and therefore we will omit such cases as not being pertinent to our inquiry. As regards other cases of chronic Bright's disease, I do not call to mind any whose origin could be stated positively as occurring in Colorado. The only cases that seem to me that can be brought forward to illustrate the effect of the Colorado climate upon the progress of the disease are those where time has been spent during the recognized course of the malady both in this and another different climate. Of such cases I have notes of only four, nor do I remember any others showing contrary conclusions. I will therefore briefly report these four cases:

"CASE 1. *Chronic Parenchymatous Nephritis.*—This patient first became aware of his disease two years ago, while on the Atlantic coast, through consulting a physican concerning a considerable swelling of the abdomen and feet. He continued to get worse for three weeks, when he came to Colorado, when I found he had ascites and general œdema, granular casts and blood in the urine, with 2 per cent. of albumin. He was treated with jaborandi, Turkish baths, Basham's mixture, and a milk diet, resulting in the removal of the dropsy and a general improvement. He remained in Colorado for a year, during which time he attended to his business, and several times walked as much as twelve miles hunting, and, except after an occasional cold or overwork, the albumin steadily diminished, so that on reaching the East it was found to be only one-twelfth of the bulk. He remained East three months, during which time he caught several colds. His general health while there was fair, though he did not feel vigorous. At the end of three months he returned to Colorado, when I found the albumin had increased to one-fourth the bulk. He remained in Colorado about nine months, and worked harder than ever at his business. During the fall, after getting wet wading for ducks, he had a considerable further increase of albumin, which afterward dropped

again, and on leaving for the East in the spring the albumin was again only one-twelfth of the bulk, with an occasional hyaline cast. Five pints of urine were passed in twenty-four hours. There was no œdema, and, except for being tired from business worry, his general health was better than it had been since the beginning of his illness. During this time he had kept to a milk and vegetable diet, with occasional relaxations, and had taken Basham's mixture most of the time. The weight increased a few pounds.

"Case 2. *Chronic Interstitial Nephritis.*—This patient had chronic catarrhal pneumonia, resulting in consolidation of the upper half of the upper lobe of the left lung. The disease was arrested before coming, and was non-progressive whilst here. The renal disease had been discovered about a year and a half previously, and was apparently the result of diphtheria. He reached Colorado in September, and remained until the following May. On arrival the albumin was one-fifteenth of the bulk of the urine, and no hyaline casts were found; amount of urine a little below normal. It was a more than usually windy winter, and it was the gentleman's custom to drive some three miles to a camp he had in the woods, and remain there until about three o'clock in the afternoon, eating his lunch and sitting in the open air or, when too cold, in a little cabin. The mornings were generally warm and still, but most afternoons he had to drive home through a cold wind. He had two slight attacks of pleurisy, but otherwise gained slowly, and on leaving was decidedly in better health. The urine was normal in amount—no casts, the albumin loss being one-twenty-fifth of the bulk. After his return he continued to live East, and died a year later from renal and other hæmorrhages after sudden exertion. The treatment in Colorado was merely general care.

"Case 3 was one of chronic parenchymatous nephritis, detected about six months previous to arrival while in the East, where he lived. There was no œdema or general debility. The record of the urine is lost, but there was a moderate amount of albumin with granular casts, and on leaving, after spending the winter, the percentage of albumin was decidedly less—very few casts, and little less than the normal amount of urine passed. He was on a milk diet. He returned East in more vigorous health, but the subsequent history I do not know.

"Case 4. Chronic parenchymatous nephritis, probably consequent on nervous shock from severe fall and injuries whilst living in the East, a year previous to coming to Colorado. This case was under observation, off and on, for three years, during which time he was chiefly in Colorado, especially during the first year and a half, but went across to Europe, and remained East during portions of the three years. When first seen there was $1\frac{1}{2}$ per cent. of albumin, numerous granular and fatty casts, slight ascites, considerable œdema of lower

limbs, and much pain over kidneys. The treatment was a mixed diet, tincture of chloride of iron, alkaline waters, and dry cuppings. At the end of three years there was no trace of albumin or casts. The amount of urine passed was about normal, and the general health good. The patient continues well and lives East.

"Each of these four patients, in contrasting their experience of the climate of Colorado and that of the East, said that they found that they less often caught cold here than elsewhere, and that when they did so they got over a cold more quickly.

Healthy Kidneys.—"With regard to the effect of climate upon healthy kidneys, persons during the first few days after their arrival have frequently called my attention to the 'thickness' of their urine, which upon examination proved to contain an excess of solids, especially the urates. These persons have usually thought also that they passed perhaps less water, but certainly more frequently. This condition usually passed off in a few days, and the urine returned to its normal appearance. This would suggest that the excretion of water by the lungs and skin was much increased at the expense of the kidneys, at least on first coming; and this the parched skin would bear out.

"My friend, Dr. S. A. Fisk, informs me that from quantitative and qualitative analyses made by him upon specimens of urine taken from healthy persons who were permanent residents, the urine was normal, except perhaps the specific gravity being slightly higher. This would indicate that in healthy persons the balance between the excreting organs is in time regained.

"The points that seem to me suggested at this stage of the inquiry, though as yet nothing is established, are the following:

"First. Acute nephritis, like all acute inflammations, is not infrequent in Colorado, especially in the mountains, where the inhabitants, not being natives, are careless of climatic extremes, and that when occurring is, like all inflammations at an altitude, more than usually acute; that acute nephritis is not especially induced by the climate, but, having risen, is in its outset aggravated by it.

"Second. The direct tendency of the climate in chronic nephritis, as in most chronic diseases, is toward its cure. This beneficial influence is mainly exerted through the increased action of the lungs, and to a less extent of the skin, affording relief from work by the kidneys, and by the general stimulating and equalizing of the circulation, lessening the renal congestion."

My observations during the past five years following the time of this report tend to confirm these conclusions. Cases 1 and 4 are still alive and well: the former lives East, and was seen by me a few months since, and the latter has returned here and does business. A case of chronic interstitial nephritis consequent upon typhoid fever came to

Colorado four years ago in poor general health, and with a few casts and a little albumin in the urine; she improved very much in her general condition, the analysis of urine remaining relatively about the same and the amount not further diminishing. She died, however, a few months since from pneumonia following a second attack of typhoid fever. This case shows that the progress of the disease, while it may not have been retarded, was not accelerated by residence at an altitude.

Sir Andrew Clark stated to me that he found that kidney affections were frequently developed among the consumptives residing in the High Alps. I do not know what was the exact nature of their disease, and I have been unable to ascertain what is the average percentage of cases of lardaceous kidney among consumptives generally. In 150 cases of phthisis which I treated in Colorado and traced up there were 4 with this complication—2 who were affected before coming to Colorado, and 2 since. In all of the patients the urine was frequently tested. It is quite common in Colorado to find in fatal cases at the last more or less œdema, but the test-tube and microscope often fail to show any renal affection; doubtless the œdema is due to the weakening heart. I believe that the somewhat prevalent opinion of the frequency of lardaceous kidney in Colorado is due to this œdema being present and no test being made. With respect to nephritis, acute or chronic, among the 150 consumptives referred to there were 3 cases. Two began in Colorado—one acutely, the other slowly. The former, who showed unmistakable evidence of a tuberculous kidney, is still in Colorado and much improved, though he has a little albumin and a few casts. The latter case died of his pulmonary disease with increase of the renal symptoms.

In the present state of our knowledge it is undoubtedly safest to try a warm climate first, which may have a high humidity, but must have a moderate rainfall. The age of the patient should much influence the choice between a warm and a cool climate, and also the stage of the disease; and whether it is reasonable to look for cure or only alleviation of the malady is a most important point.

Diabetes, both mellitus and insipidus, would appear not to be diseases *per se*, but symptoms resulting from disturbance of the functions, or change in the structure of, some portion of the nervous system or of one or more of the digestive organs, notably the liver. Change of climate, though not usually of the first importance in the treatment of this disease, is often an aid to other therapeutic measures. The choice must then be determined by the primary causes of the affection, as, for instance, when the cause appears to be too high living in a full-blooded person, a low unstimulating climate at a spa, such as Carlsbad, where the waters are rich in the salts provocative of increased metabolism, is indicated. When, again, digestive or excretory causes are at the root

of the matter, and the patient is of the anæmic type, the mountains are of the most avail. Where the nervous system seems most to blame, and when an actual lesion is suspected, a warm sea-shore is generally indicated, while in cases in which the nervous symptoms are functional and more or less anæmia is present, elevated climates will probably do more to retard or cure. I have watched with interest the progress of several cases of diabetes while they resided in Colorado, but have been unable so far to come to any conclusions on the influence of altitude upon the disease.

Hepatic Affections.

Where there is evidence of a serious organic lesion the only change of climate admissible would be a comparatively negative one. In functional disturbance, on the other hand, climatic change of a positive character, as from sea to mountain or *vice versâ*, is often of the greatest benefit. The direct influence of climate is perhaps more marked upon the functions of the liver than on any other organ. Speaking broadly, persons may be divided into those who are made bilious by going to the sea-shore, and those upon whom the mountains have a similar influence. It will be found, as a rule, that with fair and full-blooded persons the liver acts best on the sea-shore, while with the dark-skinned and anæmic in mountain-air the hepatic functions are the most regular. The question is, Do the nervous or circulatory systems call for a sedative or stimulating tonic quality in the air to provoke or regulate the necessary metabolism and thus bring back health? Dr. Weber and other writers on climatology have spoken of the favorable influence of elevated climates upon sluggish circulation in the abdomen generally, and so it has appeared to me that passive congestions in anæmic persons were usually benefited at an altitude, while it failed to agree with the full-blooded or those in whom there were active congestions or marked nervous irritability.

Attacks of Gall-Stone.—To remove the conditions upon which the formation of gall-stones is dependent certain drugs are generally called for, notably sulphate or phosphate of sodium, and clinical experience indicates that these are of most avail when administered in a natural mineral water. A suitable spa should therefore be sought, but to get the best effects one should be selected in a climate that is best suited to the patient upon the general principles already laid down. The success or failure of treatment at Carlsbad is undoubtedly mainly due to these general principles. As balneotherapy does not lie in the range of this article, I cannot well pursue the subject further, but I may mention that I have been much gratified by the prompt results in the treatment of gall-stones by the use of the Shoshone Spring at

Manitou, Colorado.[1] Some of the cases had previously been treated at Carlsbad with very imperfect results. The Manitou spring is very much less rich in the requisite salts, and often requires an artificial addition; I cannot therefore but believe that the climate as well as the spring is often not sufficiently considered.

Affections of the Stomach and Bowels.

Very little can be said about the influence of climate upon such disorders, except to follow the general principles laid down concerning other diseases, and to fit the climate to the individual rather than to the disease. Temperature has, as has been elsewhere pointed out, the most marked influence upon the secretion from the intestines. As a generality, it is true that a hot climate provokes diarrhœa and a cold one constipation; while as regards the effect of humidity, though it tends to increase the amount of diarrhœal affections, yet where heat is present in spite of the absence of humidity not a little diarrhœa and dysentery is found, though seldom of as grave a character as in warm damp climates. The cause is probably in the marked change between day and night, sunshine and shadow. Cases of chronic diarrhœa and dysentery and chronic dyspepsia, as well as chronic ulcers of the stomach and duodenum, which have arisen while the patients were residing in low climates, and which the best therapeutic measures at home have failed to cure, will frequently recover under similar treatment if they remove to an altitude; and, on the other hand, I have known cases arising in Colorado, which have become chronic, that were quickly benefited by a change to the sea-shore.

Conclusion.—We have now travelled over the main routes which open up the field of climatotherapy, and have endeavored to exhibit the general principles, though not the details, of the subject. The scientific study of climatic therapeutics may be said to be in its infancy, and although the literature of the subject is abundant and is enriched by valuable works, such as those of Weber, Lombard, Hirsch, and others, yet the grains of wheat among the chaff are comparatively few and widely scattered. Most writers in describing the effects of a particular climate write empirically, but without having first studied the known facts and general principles of climatology, and do not connect their fragmentary studies with the general subject, and do not even give logical reasons for their statements where other proof cannot be obtained. Verbose or poetical descriptions of scenery or glittering generalities fill out the most of such articles, and a claim for therapeutic virtue in the particular climate for the most opposite pathological conditions is made, the writers failing to recognize that the more positive the

[1] See *Manitou, its Mineral Water and Climate*, by S. E. Solly, M. D.

climatic effect in one direction, the more positive it is also in the other; in short, that a shield has two sides. When we come to clinical statistics we realize the poverty of the literature and how rich a stream of knowledge is flowing away in thousands of health-resorts all over the world. Of course it is the quality and not the quantity of the records that is wanted, and the careful following up and recording of cases is attended in all chronic diseases with especial difficulty and demands much time and labor. The neglect to record clinical results, especially among those most interested—viz. specialists who send to, and the local physicians who care for, invalids at health-resorts—is very great. This is markedly shown in the comparatively few records of phthisis I have been able to present, only obtaining fifteen sets of statistics. However, there is now awakened a much greater interest than ever before in the whole subject of climatology, and we may look with hope to the future; in the mean time we must speak without dogmatism or extravagance, and learn the lessons that the few facts we have can teach us before we speak at all. In selecting a climate for an invalid let us above all remember to examine not only into the suitable application of the climatic factors to the disease, but also into the peculiarities of the individual and his attendant circumstances.

HYDROTHERAPY AND MINERAL SPRINGS.

By SIMON BARUCH, M. D.

HYDROTHERAPY.

Hydrotherapy is a term derived from ὕδωρ, "water," and θεραπεια, "treatment," which may be applied to the methodical application of water for remedial purposes, either hygienic or therapeutic. The term has been erroneously applied to the external application and drinking of cold water alone. This is probably due to the popular use of the word *water-cure* adopted by the empirics calling themselves hydropaths, who originally confined their practice to water of low temperature.

Guided by the correct derivation of the term, this article proposes to discuss the therapeutic uses of water in all its forms, from the lowest temperature to the highest, including its application *within* the cavities of the body as well as upon the surface.

Baths for Hygienic Purposes.

Among the agencies which the experience of the human race in all ages has demonstrated as conducing to the preservation of health and the prolongation of life, personal cleanliness takes the most prominent position. Physiology confirms the correctness of this popular idea. The enormous surface of the skin, supplied as it is by all the nervous and vascular accessories which make it a vast gland, causes it to be one of the chief, if not the foremost, depurative organs of the body. Hence its proper discipline becomes a valuable preservative of health, since many diseases are traceable to the influence of temperature-changes upon the skin.

The application of baths for hygienic purposes begins with infancy, when the sensitive condition of the skin demands a careful adaptation of temperature. The daily warm bath, from 90° to 100°, has become a practice among the better educated people for children. Unfortunately, the practice is discontinued too frequently later in life. The advantage of cleanliness as an element of hygiene need not here be dwelt upon. But the value of bathing in lower temperatures for the purpose of maintaining the reactive power of the skin cannot be too emphatically insisted upon, because experience has demonstrated its

effect in protecting the system, commonly termed the "hardening effect." For this purpose a daily rapid contact of the body with water of sufficiently low temperature to produce a shock, which is followed by reaction, is required. That the physician should insist upon not only the frequent systematic cleansing of the body with warm water and soap, which soften the epidermis and remove accumulated secretions, is a trite and oft-repeated idea. But that he should instruct those under his care, especially when young, to accustom the skin to rapid temperature-changes by systematic cold ablutions, followed by exercise, is not regarded as imperative unless some ailment brings the subject to his notice.

The mode of life of the present generation, which differs from that of more primitive times by intensifying the nervous energies and enhancing the desire for stimulating food, drink, and occupation, which conduce to a diminution rather than an increase of physical vigor, demands the introduction and popularization of some method of counteracting these influences. Weak constitutions, manifested by anæmia and muscular inadequacy, have been notoriously improved by climatic influences and outdoor life. If to these were added that methodical daily contraction and subsequent dilatation of the peripheral blood-vessels resulting from a brief cold plunge or sponging, these vessels could be endowed with the same tone and vigor which gymnastic exercise confers upon the voluntary muscles. This is the essence of the "hardening process," as it furnishes the means of improving the functions of the body which depend upon the integrity of the neuro-vascular supply of the skin.

Aside from this effect, this neuro-vascular discipline protects the system, as has been stated above, against those deleterious temperature-influences termed "colds." The exact *modus operandi* of the factors involved in this common process is unknown—whether it be neuropathic, by irritating the terminal sensory nerve-endings, and thus producing reflex vaso-motor and trophic disturbances in the mucous membranes or in the internal viscera, or by chemical changes in the blood, as Senator claims in rheumatism, or, as Winternitz perhaps more correctly surmises, by retention of products of tissue-change. That the thermic impression is most frequently upon the periphery of the body daily experience testifies when we are exposed to a draft of cold air; that it is probably a reflex from the peripheral nerves to the vaso-motor nerves within the body, the rapidity of the effect would confirm. Hence, the education of the peripheral nerves to bear these irritants without resentment would afford protection against them. A diminution of irritability is thus induced by the daily peripheral neuro-vascular exercise caused by cold bathing, which results in "hardening." The most useful method is the gradual accustoming of the body to the shock

from cold water, which is always followed by reaction if the temperature be correctly chosen. To ensure care it has been the author's habit to advise standing in twelve inches of water at 100° F., and resorting to a rapid sponge-bath of 80° F. This is reduced daily two degrees, until a temperature is reached below 50° F. When this has been done a few days, a daily plunge into water at 80° F. is advised, the temperature of which is reduced in the same manner until 50° F. or lower is followed by an agreeable reaction. This is manifested by a pleasant warmth and absence of prolonged coldness of the feet and hands. This bath should be taken in a room having a temperature of not less than 65° F., and ample provision for the rapid execution of the bath and the subsequent drying of the surface should be made. Such a bath has served as a preservative of health and strength in feeble individuals with a tendency to disease, especially in anæmic literary and professional people and in persons who lead a sedentary life or who are subjected to great mental strain in the pursuit of their avocations. Unfortunately, the facilities for such baths are open to but a small portion of the community in cities and towns. But even the humblest dweller in the rural districts may contrive a simple cold sponge-bath if he can be made to understand its value as a preserver of health and a promoter of longevity. The poor in our cities, however, crowded into tenement-houses in which one faucet usually supplies an entire floor, are debarred from this wholesome hygienic measure because of lack of room. Physicians frequently observe how the filthy condition of our poor is responsible for the spread of many diseases. The so-called "tenement-house odor," which so often offends in crowded street-cars or halls, is evidently nothing more than the decomposed sebaceous secretions which have accumulated in unventilated clothing. The modern sanitarian recognizes that in purifying our habitations and our persons lies the great prophylactic.

Public Baths.—Public baths for the poor are becoming more and more clearly recognized in modern times since the first one was established in 1842 in Liverpool. The English Parliament took an active interest in the matter, and encouraged their establishment in the United Kingdom by its wise enactments; and France and Belgium soon followed this example. But Vienna led the world in establishing the ideal baths for the poor in the Volksbad in the Mondscheingasse, which many other German cities have imitated. In his report as chairman of the Committee on Hygiene for 1890 of the New York County Medical Society the writer suggested the erection of similar baths, insisting that the following points be observed:

1st. The baths must be located in the very centre of the crowded districts.

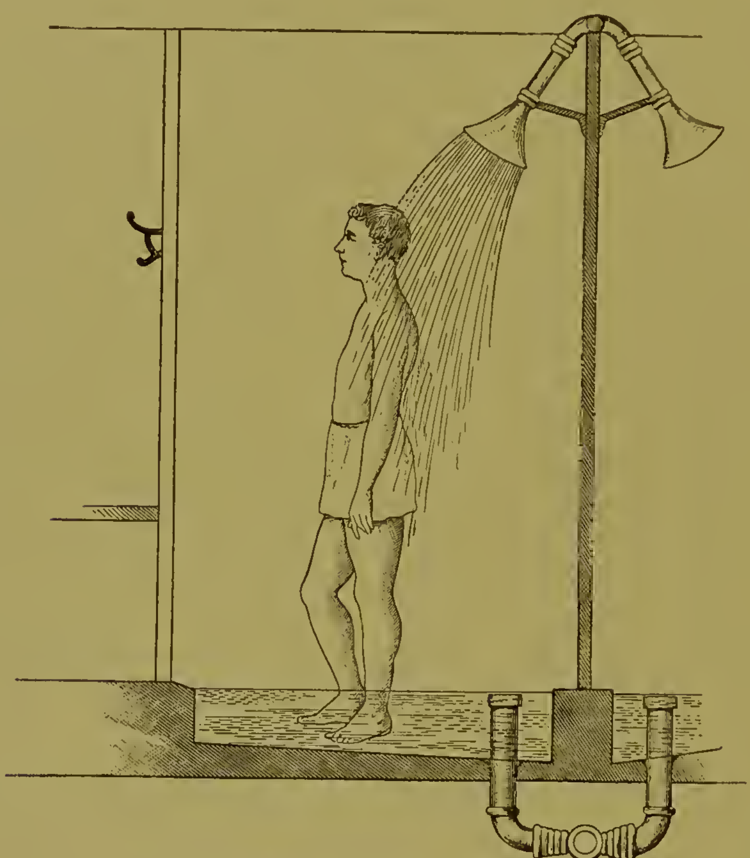
2d. Their exterior must be modest.

3d. They should be so constructed that a thorough cleansing bath may be obtained without trouble or expense and without sacrifice of much time.

These conditions may be fulfilled only by the abolition of the bath-tub and the substitution of the warm rain, or shower-bath for the old-fashioned tub-bath. The advantages of such a bath, falling upon the body with considerable force from a reservoir of some height, are self-evident. By this means—

(1) The outlay for tubs is avoided, as well as the cost of the wear and tear.

Fig. 127.



Compartment for Public Baths.

(2) The avoidance of filling, emptying, and scrubbing of the tub, for each bath economizes labor and expense.

(3) The time needed for a cleansing bath is far less, and the cleansing more thorough, because the patient does not bathe in water already soiled.

(4) The space required is one-half.

(5) The water required is about one-tenth.

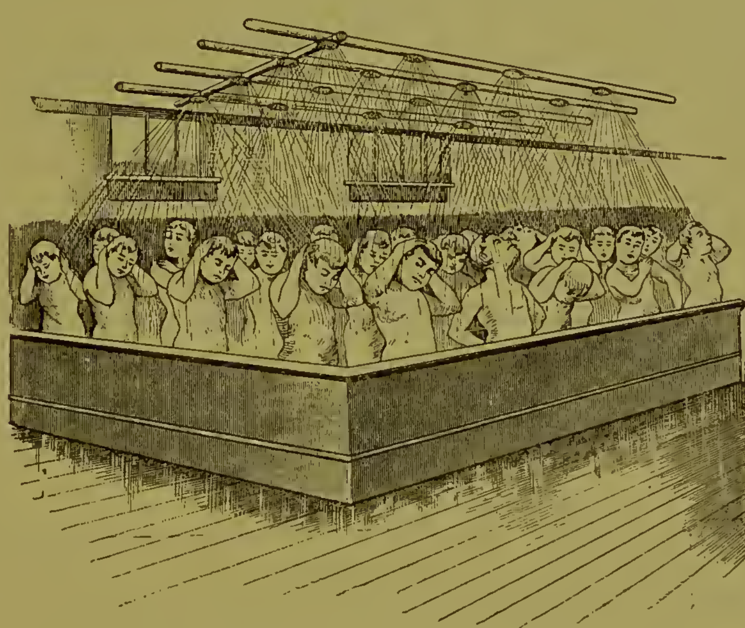
(6) The danger of communicating disease is removed.

(7) The refreshing effect of a cold shower after a warm bath may be secured.

The bather simply steps upon the inclined asphalt floor, opens the valve, and allows the coarse stream of warm water to descend upon him, while he soaps and rubs himself. The soiled water runs off, and the next bather may at once enter.

For public institutions, where large numbers require bathing, the economy and practical value of these rain-baths will be a great boon. I have introduced them into the New York Juvenile Asylum. The arrangement of pipes near the ceiling is provided with sixty-eight convex sprinklers, 2½ inches in diameter, 20 inches apart, throwing a stream which widens to fifteen inches, and is placed over the tiled slanting floor of the bath-room. By mixture with steam the water is heated

FIG. 128.



Author's Bath at the New York Juvenile Asylum.

to the proper temperature. Two hundred and eighty-one children are bathed each hour, while by the plunge-bath only eighty could be bathed in the same space. The consumption of water is reduced to one-eighth by exact measurement.

The Association for Improving the Condition of the Poor of New York has also adopted this plan at my suggestion, and is now constructing a public bath on the Centre Market Place, which, it is hoped, will be an example followed by the authorities of this and other cities. The cheapness and practical utility of these baths must commend them to those having the care of the health of communities or large institutions.

HYDROTHERAPY IN DISEASE.

The therapeutic value of water is established by the most convincing evidence, obtained at the bedside in all countries and in all epochs of

the history of medicine. While other remedies which have been heralded as prolific of good have been cast into everlasting oblivion, or have from time to time enjoyed a more prolonged reputation, water is the only remedy which has stood the test of time since Hippocrates furnished medical literature with the first treatise on the subject. Bloodletting, which from the earliest dawn of medicine rallied the best minds to its support, and for some time towered above all other methods of treatment and resisted the onslaughts of its few yet able opponents, lost its foothold so soon as the light of modern research exposed the fallacious reasoning upon which it is based. Water, on the other hand, whose paternity is coeval with this once universal remedy, but which never approached the same complete dominance, is to-day more highly esteemed than ever by some of the best clinical observers. The more fiercely the light of modern research beams upon it, the more glaring become its points of vantage, because its application is based upon well-recognized physiological principles. The verdict of history is pronounced in favor of water as a valuable (but not universal, as the hydropaths would make it) remedy. That in all epochs the most brilliant minds advocated its use most earnestly a brief reference to history will demonstrate. Hippocrates devoted one of his books to the discussion of water as a remedy. His acute observations demonstrate the principles of hydrotherapy in an empirical but correct manner. He discovered the stimulating or warming effect of cold water and the soothing effect of warm water, and utilized the former in syncope and the latter in insomnia; he discovered the diuretic effect of the cold bath in fever, and even insists that it is more useful in inflammation of the lungs than in ordinary fevers, because it renders the expectoration more fluid and relieves dyspnœa and pain in the side. Asclepiades of Prusa, whose brilliant accomplishments made him the intimate of Cicero, and who was the founder of the school which furnished men like Themison, Antonius Musa, and Celsus, was an ardent advocate of water as a remedy. In his *De re Medica*, third book, Celsus recommends cold ablutions and the cold bath in fevers, and insists upon their early application. Galen too, frequently advises the use of cold water, and the use of cold affusions to the head while the patient sits in warm water—a method to-day resorted to in the collapse, coma, or in the somnolence of fevers—originated with him. In his seventeenth book the directions for treating fevers by cold are marvellously clear; they could be literally transcribed and utilized to-day. His theory of hyperpyrexia and its treatment is in accord with that now accepted. He says the only cure of fevers is by abstraction of heat after the cause is removed.

A great cyclopædia of the medical sciences, published by Oribasius

in A. D. 360, contained a chapter on "Febris Exacerbatio balneis naturalibus curata."

Rhazes ordered in measles that "as soon as dyspnœa becomes very great a cold bath must be given, and the body must be well rubbed until the eruption appears." We cannot improve upon these suggestions at the present time.

That the use of water was popular among the Arabian physicians is testified by Prosper Alpinus, who visited Egypt in 1580, and observed that "the people take a lukewarm bath for refreshment, often dipping themselves afterward in cold water; not only the well, but those sick with fever, do this." Thus had the doctrines of the Alexandrian School, which utilized baths and cold drink in fevers, been transplanted into Egypt and endured a long time.

In the seventeenth century we find the great Dutch physician Herman Vander Heyden a warm advocate of water in disease. His 363 cases of malignant dysentery recovering under hydrotherapy are among the most brilliant achievements in clinical medicine. Van Helmont also used water extensively.

England has contributed probably as much as any other country to the dissemination of hydrotherapy. Floyer's *Inquiry into the Right Uses of Hot, Cold, and Temperate Baths*, published in 1697, is a classic which has been translated into all modern tongues. The practice of hydrotherapy was warmly adopted by Baynard, Blair, Brown, Pitcairn, Cheyne, Huxham, and other eminent practitioners, chiefly in acute diseases.

Floyer's learned treatise made such an impression upon Friedrich Hoffman that the latter taught this doctrine and practice from his university chair, basing the action of cold water chiefly upon the effects upon the tone of the blood-vessels. Thus was it disseminated among educated physicians in Germany. Later, such men as Van Swieten and the Hahns, father and son, espoused hydrotherapy as a part of their practice in acute and chronic diseases, especially in the exanthematous fevers.

The exploits of Wright and Currie, which were published in the last years of the eighteenth century, are to English and American physicians the most familiar historical facts connected with hydrotherapy. How correctly Currie estimated its rationale in typhus and low forms of scarlatina is evident from the following passage: "We are not here to await the good offices of Nature and assist her supposed efforts, but to combat the fever in all its stages with our best powers;" and he used cold sea-water, 37° F., because of its greater irritating effect, which produces reaction. A proof of the proselyting influence of the work is cited by Pollak, to whom I am indebted for many historical data. Franck, who was an enthusiastic apostle and studied

under Currie, introduced his methods into the Viennese Hospital, where they have since held almost constant sway under men like Hirschel, Froehlich, Mauthier, Plith, Plennger, Dunnreicher Friedman, Rosenthal, and, last and far from least, the father of scientific hydrotherapy, Wilhelm Winternitz.

The eminent Italian physician Joseph Giannini says: "Humanity owes Currie a debt of gratitude for having brought to a correct light so excellent a procedure, and having so bravely taken up the battle against prejudices." This practitioner discovered the value of full baths, which he advised night and day when required by high fever, and thus laid the foundation of the great triumph of the Brand treatment of to-day.

As one name among many illustrious advocates of hydrotherapy in Germany must be remembered Hufeland the philosophical physician, who was so deeply interested in the subject that he offered a prize of fifty ducats for the best essay, which was carried away by Froehlich, the Austrian court-physician, who demonstrated his great confidence in hydrotherapy by insisting that it was capable of shortening typhus if used in the very inception of the disease.

During the past thirty years, which may be regarded as the most eventful epoch of medical history—a period during which the doctrines of schools were displaced by the exactness with which instruments of precision invested diagnosis, by the light thrown upon disease by pathological and microscopical study, and by the great chemical discoveries which promise to bring therapeutics abreast of diagnosis—water has risen to a higher status than ever before. In every country where medicine is cultivated assiduously there are men of acknowledged ability as clinical observers who are not only warm but energetic advocates of hydrotherapy. Semmola and Cantani in Italy, Liebermeister, Ziemssen, and Strümpell in Germany, Dujardin-Beaumetz and Glenard in France,—these are names which stand as vouchers for any therapeutic method, and bid us carefully scrutinize it ere we are moved by prejudice to reject it.

While the modern practitioner happily owes allegiance to no school and is not under the thraldom of any authority, let him not disregard the clinical results, based upon rational principles, which are recorded on the subject of hydrotherapy.

To bring the American physician more *en rapport* with the justly eminent advocates of this method is the aim of this article.

Rationale of the Action of Water.

The action of water as a remedial agent may be explained upon strict physical and physiological principles. Its effect upon the body is traceable—first, to mechanical impact; second, to temperature effects.

These effects are modified in accordance with the part to which the application is made, the condition of the individual, and his environment. As an illustration may be mentioned the effect of an application of melting ice to the toes in a healthy individual while awake or asleep, drunk or sober. The mechanical impact produced by friction of the water from a douche—which is a stream propelled with force by two or more atmospheres—will produce the effect of massage of the part.

Tuerck has shown that anæsthesia of the skin may be removed by gentle rubbing, and that friction or pressure acts upon the peripheral circulation is constantly observed. Stroking the skin with the fingers leaves pale lines, resulting from the driving of blood from the superficial vessels, which, however, immediately disappear. This effect produced by mechanical impact upon the peripheral vaso-motor nerves, both stimulating and relaxing them, is conveyed to the central nervous system, which responds by effects upon the respiration, the cardiac movement, the distribution of the blood, and the vascular tension. Thus the local disturbance of the circulation by mechanical impact of fluids becomes an important factor in hydrotherapy, to which reference will be made later.

Second, the temperature effect produced by water is really the chief element in its therapeutic application. To realize fully the importance of this proposition reference need only be had to the anatomy and physiology of the skin as it is revealed by modern researches. Briefly and simply told, the skin presents not only the most extensive continuous vascular and nervous area of the body, but it is the most accessible surface to all external impressions. Herein may be sought the relation and importance of the skin to all the systemic functions. The large cutaneous surface stands guard, as it were, over the entire body. Being a sensory organ, it receives all impressions of irritants, be they thermic, mechanical, chemical, or electrical, which may combine all.

Thermic irritants, heat and cold, are the chief elements in all hydriatic procedures. They make impressions upon the terminal nerve-endings which abound upon the cutaneous surface. The sensory impressions act in a twofold manner: First, they are conveyed to the central nervous system, whence reflexes are emitted which have the most important bearings upon all the functions of the body. Second, the effect upon the vaso-motor nerves produces a narrowing of the surface vessels, which increases the resistance to the circulatory current and thus raises the blood-pressure. This constriction is followed, in accordance with familiar physiological laws, by relaxation; and this effect depends, in turn, upon the extent and intensity of the irritation.

These simple and briefly-stated physiological facts furnish an explanation of the seemingly paradoxical effects of hydriatic procedures. They also furnish the key to the remarkable yet positive

effects which the latter are capable of producing upon the respiration, circulation, tissue-metabolism, secretion, and temperature-changes of the human organism.

Effect of Peripheral Irritation upon the Respiration.—At the very dawn of life we are forcibly reminded of the influence of cutaneous irritants upon the respiration. The first inspiration is due partly, if not chiefly, to the impact of colder air upon the surface of the infant; and a most reliable measure for the establishment of retarded inspiration, and for its maintenance when feeble, is the dashing of cold water upon the cutaneous surfaces, and, that failing, the rapid variation of hot and cold impressions (by dipping in warm and cold water) upon it. The familiar example presented by the ordinary treatment of syncope, by dashing cold water upon the exposed body, is another illustration of the powerful influence of thermic irritants upon the respiratory innervation. That heat produces the same effect as cold has recently been the experience of the writer. After an operation for an abscess an extremely sensitive male patient swooned away, presenting tonic contraction of the muscles and complete cessation of respiration and pulse. Dashing an entire basin of cold water (about 65°) upon the face produced not the slightest effect. A pitcher of hot water being convenient, I poured about an ounce on one leg which was hanging lifeless over the edge of the bed. The patient at once was aroused to consciousness, but he suffered from a burn for several days.

The first effect of cold upon the terminal nerve-endings with which we shall have chiefly to deal in this article is the conveyance of the irritant impulse to the respiratory centres, producing a gasping respiration, which gradually deepens and becomes more rapid. It is difficult to separate the effect upon the respiration from that upon the circulation. The proportion which exists between the number of pulsations and respirations is usually changed by the application of cold. Deep inspiration must facilitate the general circulation, while it offers a certain resistance to the internal circulation. Complete expirations have the opposite effect. Whatever influence, therefore, is brought to bear upon respiration must to a greater or less degree affect the circulation also. The deepening of the inspiration by cold upon the surface, if not excessive, is so well established by daily observation that it requires only this brief reference. Even the empirics have recognized this fact, inasmuch as they invariably order the patient to go into the open air after most hydriatic procedures. The deepened involuntary inspirations enable the patient to obtain a large supply of oxygen, which, after all, is the chief life-giving element in nature, and when abundantly but not artificially supplied to the lungs excels all medicinal tonics in restoring the functions to a vigorous norm.

Effect of Peripheral Irritation upon the Circulation.—This effect

is local and general. The first result of a local application of cold or of extreme heat is contraction of all the muscular tissues coming in contact with it. Hence the muscular fibres of the skin, as well as the circular fibres of the cutaneous vessels, are contracted, with the result that the latter are emptied, as is evidenced by the pallor and shrivelled condition assumed by the skin. In this way we have the washerwoman's hand from heat and the cutis anserina from cold. At this point comes into play the physiological action of all organic muscular fibres. The latter respond slowly to stimuli and recover from this action with equal tardiness. Still, even this effect may be modified by the intensity and duration of the application. The more intense the latter, the more rapidly will the vessels contract and become anæmic. A brief application will result in rapid reaction, while if the application be continued reaction will be interfered with; paralysis of the vaso-constrictors will result from over-stimulation; the vessels will dilate; the skin will become red, and lastly, cyanotic. The vitality of the part may thus be reduced, when anæsthesia results, and if the cold be continued destruction of the part ensues.

Thus we may induce in the circulation innervation and nutrition of the part by the simple application of cold to any portion of the periphery, a powerful change either for good or for evil. The immense latitude of effect between the application of moderate and extreme cold is made evident at once. Extreme heat, it should be remembered, produces an analogous effect.

The cardinal point to be remembered here is that *a brief and intense application of cold is a stimulant, because it is at once followed by a corresponding reaction, while a prolonged application is a depressant.* And in the practical application of hydriatic procedures, this fact will be frequently recognized.

The general effect upon the circulation produced by cold must necessarily be traced to its impression upon the heart. Among the numerous positive and valuable contributions to scientific hydrotherapy, for which we are indebted to Winternitz, the effect of thermal stimulants upon the heart stands foremost. By means of sphygmographic tracings he learned that cold applied to the surface produced an immediate cardiac response by increasing the pulsations, but was immediately followed by a slowing of the heart's action. The opposite effect resulted from the application of high temperatures to the surface; and here, again, the effect, being reflex, depended upon the susceptibility of the individual to impressions.

The classical experiments of Naumann, in which the trunk of a frog was left connected with the leg only by means of the sciatic nerve, clearly proved that thermic and other stimuli applied to the web produced an immediate change in the circulation of the mesentery. From

these experiments he justly concluded that the irritants applied to the surface act upon remote parts by a reflex wave from the central nervous system; that intense stimulation of the surface diminishes the cardiac force and activity, dilates the vessels, and slows the blood-current; that weak stimulation of the surface increases cardiac activity, improves the force of the heart, diminishes the calibre of the vessels, and accelerates the blood-current; and that these effects continue for some time, according to the intensity and duration of the application.

That this effect upon the heart may be produced by other channels also is shown by the fact that in the heart removed from the body of an animal the application of cold produces a diminution, and that of heat an increase, in its contractions, and by the observation that the passage of cold or hot fluids through the heart has a similar effect when it is still connected with the body. Thus, it is demonstrable that the cooling or heating of the blood-current distinctly affects the cardiac nerve-ganglia.

Aside from the direct effect upon the innervation of the heart, the action of the latter may be, and is readily, influenced in two other directions. Pulse-tracings demonstrate that inasmuch as by cold impulses are conveyed from the periphery through the sensory and returned through the motor tracts, a reflex stimulant effect upon the force of the heart may be produced which offers many valuable hints in the treatment of organic and functional cardiac trouble. Moreover, a very important channel through which cardiac activity and force may be enhanced is to be sought in the relations existing between the peripheral and capillary circulation. One of the important agencies in controlling the frequency of the pulse is the resistance offered to the current of blood by the arterioles and capillaries. This resistance diminishes the frequency and increases the force of the systole, while diminution of the resistance of the arterioles and capillaries increases it.

Clinical demonstration of this effect is constantly observed in fevers. The rapid, dicrotic pulse, due to a lack of resistance in the peripheral vessels, as will be shown later, is at once changed into a more deliberate pulse of almost normal tension by the appropriate application of the cold bath. The latter acts, not by narrowing the cutaneous vessels, as is generally supposed, but by stimulating them to resume their functions of contracting upon the blood, which has been flowing through them as through a dead or paralyzed tube. This restoration of normal resistance in the arterio-capillaries restores the lost equilibrium between the latter and the heart. The cardiac systole becomes normal, the pulse slower and more natural. This effect I have often observed in typhoid fever, as will be shown later.

It is important to note the modifying influences arising from the impressionability of the individual, the condition of his health, the

character of the disease, the method of application, and the intensity of the thermal irritant. E. Delmas Saint-Hilaire[1] has shown as the result of thermometric and sphygmographic experiments that all physiological and therapeutic manifestations produced by cold are to be explained by the impression transmitted to the nerve-centres from the peripheral nerve-endings. This primary thermo-dynamic action upon the nerve-centres is at first transferred to the respiration and circulation.

The Reflex Effect of Cold upon Cardiac Action.—This effect is frequently manifested by rapid contractions, and generally by a considerable rise of arterial tension. Shortly afterward, however, the frequency of the pulse diminishes, falling below the previous number, while the heightened tension in the vessels continues to exist. The effect of cold upon the cardiac action and the peripheral vessels depends also upon the subsequent muscular quiescence or activity of the individual. If the latter remains quiet, the heart-action is accelerated at first, but quiets down afterward. If he exercises, the pulse becomes more slow at first. The more quickly exercise follows upon the douche, the greater will be the fall of temperature, slowing of pulse, and diminution of arterial tension. The tension of the pulse is greatest at the moment of impact, when the heart-action is most rapid; as the latter diminishes the tension is also lower, but does not fall so low as it was before the douche. So soon as reaction takes place and the peripheral surfaces are warmed, the frequency of the pulse diminishes.

Physiological experiment explains these effects. When the sympathetic nerve is divided the intestinal vessels become distended with blood through inhibition of the power of the constrictors, while the dilators, which are probably of spinal origin, remain active. The result is a loss of tone in the entire vascular system, which endeavors to accommodate itself to the abnormal distribution of blood. Even in the vessels of the retina Basch and Hock have observed contraction, and consequent anæmia, when the sympathetic nerve was divided. In the same manner may the intestinal and retinal vessels be rendered anæmic by irritating the terminal fibres of the divided sympathetic. We have here an explanation demonstrated by actual physiological experiment, and not resting only upon plausible theory or clinical observation.

As additional evidence of the effect of peripheral irritants, Max Schueller's experiments may be referred to, which offer the most incontrovertible evidence of the influence of thermic irritants on the circulation in various parts. After trephining a rabbit without injuring the dura mater, Schueller observed through the transparent cerebral cover-

[1] *Étude statistique et clinique du Service hydrotherapeutique de l'Hôpital St. André de Bordeaux, etc.*, Paris, 1879.

ings the normal condition of the vessels of the pia mater. He then removed the superior ganglion of the sympathetic on one side, and applied pieces of ice upon the dura mater without any material effect upon the subjacent vessels; while a similar application upon the other side produced energetic contraction of the vessels, which continued for half a minute after the removal of the ice. In another trephined animal Schneller observed the circulation in the pia mater during various other hydriatic processes. A cold compress placed upon the animal's belly or back immediately produced continuous dilatation of the veins and arteries; the cerebral pulsation became more slow and pronounced; the respiration was deepened and retarded. This remarkable phenomenon continued a few seconds after removal of the compresses, and was followed by an evanescent narrowing of the vessels before their resumption of normal calibre.

When heat was used it was found that a warm, moist compress applied to the belly or back produced narrowing of the vessels of the pia mater and diminution of energy in the pulsations, while the latter were rendered more frequent and the respiration became shallow and accelerated. A very hot compress applied to the belly produced temporarily the same effect as a cold one. When the body of the rabbit was placed in a bath the same effect was observed, being governed in extent by the extent of surface exposed and the temperature of the water.

Schneller tested all hydriatic procedures in this manner, and thus established their value upon an exact scientific basis.

It follows from these well-ascertained facts that *by means of hydrotherapy we may exercise perfect control of the pressure and distribution of the blood.* But it must be remembered that the various compensatory provisions which exist for the preservation of the systemic equilibrium decidedly oppose a too active interference with the elements constituting the hydraulic apparatus which is represented by the heart and blood-vessels. We know, for instance, how the distribution of blood to the organs is governed by their activity, and that *it may be increased or diminished from ten to twenty times.* It has been asserted that when the vessels of the skin are filled to their utmost capacity they may contain 66 per cent. of the entire quantity of blood in the system.

Winternitz has shown by means of the plethysmograph, which measures and records the volume of parts with precision, that an increase of volume due to the afflux of blood to the part may be readily produced in individuals subjected to various hydriatic procedures. The left arm of a man sitting in an empty tub was placed in the instrument. When the lower part of the body was covered with water at 50° F., the tracing made by the instrument at once recorded an increase of volume in the arm, which continued twenty seconds, and

gradually diminished without returning to its original proportions. The opposite effect was produced by warm sitz-baths.

These brief yet positive data suffice to explain not only by theoretical and empirical observation, but upon an exact physiological basis, the enormous influence which hydriatic applications to the periphery may exercise upon the blood-supply, blood-pressure, and consequently upon the action of the heart.

Influence of Peripheral Irritation on Temperature-changes.—The effect of hydriatic procedures upon the systemic temperature has long been observed as the most palpable evidence of its power upon the human organism. Indeed, it was the first observation recorded by Hippocrates, and has since been so constantly reaffirmed without successful contradiction that it has become axiomatic. *A priori*, it would appear that this temperature effect is due to the effort at equalization of temperature which constantly ensues when two bodies of unequal temperature are brought into intimate contact. While this is the case in inanimate bodies, the result is quite different when the human body is subjected to temperatures differing from its own. Parts distant from the heart are more readily cooled, as are also parts whose volume in proportion to its surface is small. Indeed, it is the activity of the circulation in a part which governs its amenability to temperatures with which it may come into contact. The heat which accumulates within organs during a state of activity is not simply radiated to neighboring parts, but it is distributed to other parts of the body by means of the circulation of the blood. This is clearly demonstrable by the fact that the venous blood from the muscles or organs when functionally active is warmer than the arterial blood supplying them.

The temperature prevailing in the skin depends upon the quantity of arterial blood circulating within it. Hence the contraction and dilatation of the peripheral vessels are the chief elements in resisting cold and heat which may come into contact with them. Very little heat is produced within the skin. It derives heat, not only from the vascular tide passing through it from within, but to some extent also by direct conduction from neighboring parts. Hence the heat given off by the skin is subject to many changes. It is also influenced by the thickness of the epidermis in certain parts, and by accumulations of fat or of fluids beneath it. Therefore, thin persons cool off more rapidly than those who have an abundance of adipose tissue. Ranke says that the activity in connective tissue is less than it is in the muscular or glandular tissues, and therefore the temperature of the skin, which consists chiefly of connective tissue, is somewhat lower than that of other parts or organs. Although constant cooling going on upon the skin prevents exact deduction upon this point, it is certain that the heat-production of the skin is compensated by the heat-loss from its

surface. This is proved by the temperature of the blood in the superficial veins, which is below that of the arteries. The arterial circulation must therefore be regarded in the skin, as in other parts of the body, as the most essential source of heat.

That the rise and fall of temperature in the human body depend upon its arterial blood-supply has been also demonstrated by Max Busch, who found, when cooling off a part of the skin, a corresponding rise in the neighboring parts, due to anæmia of the former and collateral hyperæmia of the latter. This, however, was followed by a dilatation of the arterioles, which is called reaction. Contrary, therefore, to the law governing inanimate objects, *the temperature of the human body never can be reduced or raised to that of its surrounding medium unless the vitality of the part exposed be destroyed.*

The entire heat-regulating arrangement residing in the skin is now made plain, and the protection enjoyed against serious temperature-invasions by the viscera, which are surrounded by muscles, is clearly accounted for.

That the human body may have its temperature elevated or lowered by being surrounded by hotter or colder media is an indisputable fact, established by many experiments, as is also its automatic protection against heat-increase and heat-loss. The application of intense heat to the surface produces contraction of the arterioles, which may go on to destruction of the tissues by withdrawal of vascular and nerve-supply. A more moderate degree of heat produces a relaxation of the surface vessels, which lose tone; the part becomes succulent, warm, and red from retarded circulation, which protects the inner organs against too rapid heating. If the surrounding medium is less hot, the surface circulation becomes more active, more heat is given off, and thus the blood brought to the surface, being cooled again, serves to protect the inner organs against too great an invasion of the heat.

On the other hand, if the body is surrounded by a temperature lower than its own, the effect again depends upon the cooling. The same change occurs from intense cold as from intense heat. Both may so contract the peripheral vessels as to destroy the vitality of the part. A less intense degree of cold applied to the skin acts, however, differently from heat, as it contracts the arterioles and capillaries, and thus weakens the force of the peripheral circulation. At the same time the blood is driven into the underlying muscles, which are endowed with more heat, and thus offer an obstruction to the invasion of injurious degrees of cold. The protection is enhanced by the reflex effect of cold applied to the surface, which produces a dilatation of the vessels supplying the muscles, and by the resultant generation of heat. As Adamkiewicz has shown, the feeble heat-conducting power

of muscular tissue adds another element to the forces which tend to protect the inner organs against dangerous invasions of cold.

It has already been shown how completely the circulation of the periphery is under the influence of the central nervous system, and how the latter may be called upon to receive impressions from the periphery and convey them back to the latter, thus completely controlling the amount of blood circulating in the skin.

It having now been demonstrated that the temperature of various parts of the body is dependent chiefly upon the amount and the rapidity of the circulation within it, it follows that the central nervous system is capable of controlling the temperature of various parts. In the skin, for instance, chilliness is a manifestation of this influence. The cutaneous vessels are contracted, heat is no longer given off freely; it is retained, and the body is protected against cold. Hence the first stage of febrile movements is a rigor. Upon this principle it would seem that the reduction of temperature by external cold application is not a reliable phenomenon. Indeed, it is held, and justly too, by some that the application of cold to the periphery produces an elevation of the body temperature by the collateral hyperæmia and consequent increase of tissue-change. Hoppe has clearly demonstrated that in a healthy man placed in a bath of 69° for a brief time the axillary temperature rises somewhat; and Juergensen has recorded a slight rise of the temperature in the mouth *during* a bath of 86° F. which lasted twenty-five minutes. This increase of temperature resulting from cold baths is constantly utilized in the treatment of chronic diseases, as will be shown later on.

Winternitz has so clearly given us an explanation of the apparent inconsistency involved in these observations that it may now be regarded as a law, that *the absolute amount of heat-abstraction does not fix the amount of heat-production, but that this is regulated by the intensity of thermic irritation of the peripheral sensory nerves.* The latter cause and control the increased heat-production by reflex action. Two cold baths of exactly the same temperature may have quite different effects upon the same individual. If the body is submerged in water of, say, 60° F., the surface is rapidly cooled, the sensory nerve-endings are stimulated, the blood is driven to the muscles, and more heat is generated within the latter. If, on the other hand, the body while submerged is constantly subjected to active frictions, the cooling will be more slow and gradual, the cutaneous vessels will convey cooled blood to the interior, and counteract also the increase of temperature by diminishing the reflex action from the surface which is the incentive of muscular heat-generation. This subject will again be referred to in the discussion of cold baths. *It only suffices here to establish the fact that the temperature of the body may, within certain limits, undoubtedly be reduced or*

raised by temperatures conveyed to it by means of water or air. This has been well established by the experiments of Liebermeister, König, and Juergensen.

But the fact must not be lost sight of that changes of temperature wrought upon the human body are *compensated* for, when the influencing thermal agent is withdrawn, by a return of the previous temperature to the normal, or by an approach to it, according to the previous condition of the body, the nature of the disease, and other agencies to be referred to later. While during the bath of from 69° to 86° the normal temperature rises, a reduction is observed after the bath, which may again, according to Juergensen, be succeeded by a compensating feeble rise. Thus, in a healthy man subjected to a bath of 95° for from fifteen to twenty-five minutes the loss of heat was equal to the normal; when the water was reduced to 77° the heat-loss was trebled, and in a bath of 68° the quantity of heat-loss amounted to five times the normal.

The influence of heat-media surrounding the body is equally pronounced. Mosler records in a bath of from 104° to 111° F. of fifty-five minutes' duration a rise to 101.6° in the mouth, and Bartels reports the rise of rectal temperature from a ten minutes' vapor-bath of 127° F. as amounting to four degrees. The writer has often seen mouth-temperature rise one degree more in the hot-air bath at the Montefiore Home, in which the head is not at all exposed to the hot air.

It would be seen that the cooling and heating effects of the baths depend upon the method, the length of time of immersion, the degree of their temperature, and the manner in which the system is capable of protecting itself against the temperature invasion. The flexibility of hydriatic procedures is thus manifested in their influence upon temperature reduction or elevation.

Effect of Peripheral Irritation on Tissue-Metamorphosis.— Ranke has enunciated the law that though the quantity of plasma and circulating albumin is constant, its production depends upon the quiescence or activity of the organs. He and Voit demonstrated that function is always connected with increased circulation in the organs, and that tissue-change is coincident with circulating activity. As the blood is the chief carrier of material for tissue-metamorphosis, it follows that any procedure by which the distribution of blood may be controlled must influence more or less the tissue-changes. And when it is considered that temperature-changes are either the cause or effect of tissue-changes, any measures which control this important factor must aid in influencing tissue-metamorphosis. That cold reduces and heat increases cell-activity is axiomatic. But these are *direct* effects, which do not so frequently come within the therapeutic domain as the *indirect* results produced by reflex agencies, and which are paradoxically contrary to these. From the cautious experiments of Liebermeister the fact has

been deduced that oxidation, as ascertained by the excretion of CO_2, is enhanced by the external application of cold and diminished by the external application of heat, *so long as the body temperature is not much disturbed.* As soon as the body temperature is reduced below or raised above the normal—which proceeding must decidedly and enduringly influence the internal temperature of the body—we have the *direct* retarding or enhancing influence referred to.

That an increased consumption of oxygen is a manifestation of the application of cold has been clearly shown by Röhrig and Zuntz.

Voit has also established the fact, and Pflüger, Samuel, Colosanti, and others have confirmed it, that non-nitrogenous matters undergo changes under the application of cold to the sensory nerves, which produces reflex contraction of the muscles. The same experimenters have shown that the opposite effect is produced by the application of heat. This, however, is limited by the degree of heat, for a very high degree will promote tissue-change, as manifested by increase of oxygen-consumption and carbonic-acid elimination, as has been shown to be the result of very long-continued low temperature. Bartels has shown that whenever the body temperature is increased by vapor or other baths, there is more urea excreted, evidencing that nitrogenized tissues participate in the conversion thus produced.

We have, then, proofs from reliable experiments that *rapid cold baths accelerate the tissue-changes* in non-nitrogenous substances, while hot baths affect not only these, but also *albumin conversion;* and that if the inner temperature is reduced below the normal, the reverse effect results.

Winternitz declares that a fair estimate of the influence of hydriatic procedures upon tissue-changes may be deduced from the fact that among several thousand cases treated in his establishment, 56 per cent. gained weight, 30 per cent. lost, and in only 14 per cent. no change in weight occurred. He concludes that it cannot be denied that the thermal and mechanical influences which compose hydrotherapy produce in the majority of cases such *changes in tissue-metamorphosis* that eventually an increase of flesh results.

Inasmuch as, according to all experimental researches, abstraction of heat produces an increased excretion of CO_2, and a larger quantity of oxygen is taken up; and as the products of retrograde metamorphosis from nitrogenous matters appear abundantly during the period of reaction, as well as salts and inorganic material, and despite these effects the body-weight seems to increase in a large proportion of cases, the conclusion is unavoidable that hydriatic treatment not only increases retrograde metamorphosis in all directions, but also enhances the building up of tissue. Therefore, this hydrotherapy is capable of *promoting tissue-change* in every direction.

My clinical observation in the Montefiore Home, which receives only incurable cases, confirms the views of Winternitz, that an improvement in the general condition and weight of a large number of cases, whose hopelessness has been attested by previous unsuccessful treatment and by every diagnostic sign, is proof that cold-water applications, carefully adapted to each case, improve the appetite, deepen the respiration, refresh every organ, and thus infuse an increased energy into the glandular and other functions which contribute to tissue-metamorphosis. The effect of temperature-enhancing procedures are, as has been already shown, equally striking. The action of the heart and the respiration are accelerated, the blood-pressure and blood-distribution are notably changed; and these marked alterations must make a decided impression upon the nutritive processes. Anton Frey[1] gives as the result of numerous experiments with Turkish baths a positive increase of urea. Still more pronounced is the change of uric-acid excretion under Turkish and Russian baths, amounting sometimes to a threefold increase. The increase is greatest immediately after the bath, but is demonstrable even several days afterward. The quantity of phosphoric and sulphuric acid is also increased.

Godlewsky's exact experiments, quoted by Frey, demonstrate conclusively that Turkish baths induce a positive acceleration of oxidation of nitrogenous substances (nutrient and tissue albumin), which continues several days. That non-nitrogenous substances may also be converted by these baths is constantly observed in the fact that corpulence may be reduced by them if the supply of fatty foods and fluids is diminished. Experiments on animals also have demonstrated this.

Another evidence of the enhancing effect of these baths upon tissue-change is found in the increased absorption of oxygen by the blood and by the excretion of more carbonic acid. These effects are greatly enhanced by the temperature-reducing procedures which are a part of the Turkish bath. The great loss of salts and water resulting from the hot-air bath must affect the composition of the blood, which must compensate the loss by drawing upon the tissues and intercellular fluids. It is reasonable to suppose that this active process induces pronounced changes in the parts involved, and thus influences tissue-change. Indeed, it has been definitely determined by C. Schmidt (quoted by Winternitz) that the withdrawal of salts, and especially of alkaline chlorides, from the blood is followed by a diffusion of albumin from the tissue-fluids. Schmidt has ascertained that there exists between the blood-salts and the plasma-albumin a constant reciprocal relation of equivalents—viz. that the blood takes up for every nine parts of albumin one part of salt; the reverse also holds good. . Hence the blood-plasma must become much richer in albumin after sweating. It cannot

[1] *Volkman's Sammlung*, 332 S., p. 3018.

be disputed that such a change in the chemical constituents of the blood must contribute to the acceleration of tissue-metabolism, as evidenced by the increased absorption of oxygen and excretion of carbonic acid and nitrogen. The recent remarkable contributions by Scholz[1] to the treatment of chlorosis by sweat-baths may be cited as clinical proof of this physiological phenomenon. His sphygmographic charts and exact records are entitled to proper consideration.

Another element contributing to acceleration of tissue-changes is *muscular activity*. This has become an axiom in physiology, and it has been shown how cold applications increase the action of muscular fibres by reflex channels.

We have therefore a truly physiological basis for the statement that hydrotherapeutic procedures increase tissue-metamorphosis.

Influence of Baths upon the Blood.—In connection with the influence of hydriatic measures upon tissue-metabolism, and its effect upon those important physiological processes which constitute the blood-making and maintaining functions, M. Thermes presented in 1878 a paper to the Société d'Hydrologie, the results of his careful measurements with Hayem's hæmometer, which demonstrated conclusively that by the judicious application of cold to the periphery the number of the blood-corpuscles was increased and their quality much improved.

Winternitz has also demonstrated with precision, by means of Fleischl's hæmoglobinometer, that the oxyhæmoglobin of the blood is rapidly and considerably augmented under appropriate hydriatic procedures.

Technique of Hydrotherapy.

The first principle of all hydriatic procedures which the reader should impress indelibly upon his mind is the necessity of an exact and precise execution of their technique. The flexibility of hydrotherapy is so remarkable that the most contradictory results may be obtained from procedures apparently similar, and the object aimed at may be totally defeated by imperfect or improper methods. In a paper read before the New York State Medical Society in 1889, I mentioned the case of a young but able hospital physician and teacher who expressed abhorrence of the bath treatment of typhoid fever because he had seen, while an interne, a nurse in his hospital succumb to it under the management of his able visiting physician, who was also a professor of the practice of medicine. When I asked him to explain the method adopted, he replied: "We endeavored to reduce the temperature by wrapping her in a sheet, placing her on a Kilbe's cot, and sprinkling her with ice-water." That such a proceeding contributed to the death of the woman I have no doubt. The brief

[1] *Die Behandlung der Bleichsucht mit Schwitzbäden*, etc., von D. Fried. Scholz, Bremen-Leipzig, E. H. Mayer, 1890.

physiological data above given will explain how the blood was driven from the surface to the inner organs, and, there being no effort made to obtain reaction by friction, the poor woman had her life-blood almost frozen in the peripheral vessels, whose coats were paralyzed rather than stimulated, as will be shown later on. The most ignorant hydropathic nurse understands that an *iced sheet* should never be wrapped around a patient without active friction; and here was an otherwise excellent teacher of medicine violating the most palpable rules of the water-treatment and infusing a prejudice against it in the mind of a young man which later years have not removed, because he would not try cold water at all. Thus erroneously have many capable men argued upon hydrotherapy and fostered the prejudice which the lay and medical public entertains against cold water. Even in the application of so simple a procedure as an enema, which depends for its effect upon mechanical distension, the mistake of using too small a quantity of water will, as every one knows, defeat the object. Instances of misapplication of hydriatic procedures come under my daily observation. Is it, then, to be wondered at that so many failures are reported when men regard the use of cold water as the only or chief principle of hydrotherapy? Hydrotherapy is a term applicable to the utilization of water in any form, of any temperature, by various media or alone. Modern medicine has enlarged the field of hydrotherapy, inasmuch as it now includes the injection of hot water into the various cavities of the body—of the stomach for certain forms of dyspepsia, of the vagina for certain pelvic troubles, of the uterus for hæmorrhage, of the rectum for dysentery. These methods for local effects will be considered later.

The minute subdivisions of hydrotherapy introduced by the hydropaths, as head-baths, elbow-baths, and wrist-baths, will here be omitted, and only those methods described which the writer has found practically useful in his own experience or in the practice of others.

In order to win the profession over to a more general adoption of water as a remedial agent I have deemed it proper to simplify its application, and only refer here to the most approved methods, whose mode of action is simple and explicable upon rational principles. These methods are—1st, the ablution; 2d, the sheet bath; 3d, the wet pack; 4th, the dripping sheet; 5th, the half bath; 6th, the full bath; 7th, the douche; 8th, the sitz bath.

Ablution.—This is the most simple and yet least frequently used procedure for a therapeutic effect. To wash the face, hands, and neck is a daily practice with all civilized people. *This is a true ablution.* How rarely it is practised in disease will at once appear. True, many medical men who are not hydrophobic order sponging for their fever patients. This is refreshing if the nurse happens to understand that it consists of an ample application of water to the skin, and not a mere

sweeping of it with a damp sponge. Ablution is better practised with the bare hand or linen wash-rag, which may convey a dash of water into actual contact with the skin. The entire body may be gone over, and the moistened parts may be, in high fevers, allowed to dry, otherwise they should be gently mopped up by soft linen napkins to avoid reaction.

The *rationale* of this method is as follows: Friction being produced by the hand, the superficial vessels are somewhat dilated; the blood contained in them returns cooled to the interior, and is replaced by warm blood coming from it. Thus a most refreshing effect upon the innervation and circulation is produced, which is conveyed to the nerve-centres.

The *indications* for the use of ablutions are many. In the early stages of all febrile affections cautious ablutions are valuable. They serve to prepare the patient for more intense heat-abstractions, while they cool and refresh him for the time being. They also furnish a valuable index to the reactive capacity of the patient, which serves as a guide to future procedures.

A most important method which I adopted at first in very feeble patients, and now apply in all persons affected with chronic maladies who are prejudiced against water treatment (the vast majority), is the dry pack, followed by ablutions. The patient is snugly enveloped in a coarse woollen blanket for a sufficient length of time to become thoroughly warm. Each part of the body is now exposed in succession, subjected to ablution with water usually at 65° (reduced daily two degrees), and then dried. After the entire body has been gone over the patient is thoroughly rubbed dry again and sent out into the open air.

The next step in the hydrotherapeutic training of the patient follows in several days. He is made to stand nude in a tub of water at 98° or 100° while he is rapidly washed down by an attendant, or if strong enough does it himself, with water at 70°, gradually reduced daily to 50°; good drying and friction finish the procedure. In a few days he is prepared to undertake any of the more heroic procedures without shrinking.

The Sheet Bath.—This is a much neglected but exceedingly useful measure. It is well adapted to cases under the influence of elevated temperatures, and may be used, as will be shown later, as a refreshing agent in some chronic diseases. The technique consists in conveying cold water by the medium of a sheet or towel, of fine or coarse texture, placed upon the cutaneous surface. The patient is wrapped in a linen sheet, wrung not quite dry out of water at a temperature of from 60° to 70°, so that it clings to him at all points. When it is applied standing his feet may be placed in a tub containing water at 95°, to prevent chilling. This prac-

tice will be referred to later. The sheet bath I desire to describe now is to be applied in bed. A rubber cloth and a blanket having been spread to protect the bed, the wet sheet is placed upon it. The patient, after having his face washed and a wet towel wrapped around his head, is now laid upon the sheet with outstretched arms. The right side of the sheet is brought around his body, and so laid across it that its edge touches the sheet at the opposite side. The arms are now brought alongside the body; the left portion of the sheet is now brought over the left arm, across the body and right arm, and tucked in along the right side of the body, a fold being pressed in between the lower extremities and the upper corner tucked in around the neck.

By passing the flat hands over the entire body the wet sheet is made to cling to the irregularities, and its warmth soon indicates the rapid equalization of temperature between the sheet and body. Now small quantities of water are poured with one hand from a vessel or a sponge upon a limited part of the body, beginning with the chest. With the other extended hand rapid passes are made over this spot until it becomes a little warmer. Thus successive parts of the body are treated except the forearms, hands, legs and feet. This is continued until the sheet appears to be uniformly cooled off or the patient's teeth chatter. He is now removed upon another portion of the bed, dried, and made comfortable. It is in our power to modify the effect of such a bath by using a sheet of finer texture or making it more wet by pouring larger quantities of water over it. Care should be taken that the chilling produced by the first impression is not prolonged into a shivering, but that gentle reaction is always produced in one spot before another is treated. This can readily be done by not repeating the water application if the part is slow in warming or if it ceases to warm under the chafing hand. The wet towel around the head should receive an occasional affusion also.

The value of this bath is very great, and its rationale is as follows: A most useful and yet mild antifebrile effect is produced, which, following ablutions, will not antagonize the patient or his friends, and yet will afford a most intense antipyretic effect, arousing the dormant nerve-energies, brightening a dull patient, and improving those functions which depend upon quickly-responding nerve-centres for their integrity and efficiency. The first impression of cold upon the sensory nerves stimulates them, and the effect is rapidly conveyed to the nerve-centres, as described above. All the reflex effects of cold applications are thus evoked. The peripheral vessels contract, but dilate again under the chafing hand. Being filled with blood, the latter is cooled off by the cold water poured upon it, until the peripheral vessels again contract and drive the cooled blood within. Thus a constant gentle, because partial, abstraction of heat is established, which even feeble patients

may bear with impunity if the foregoing directions are judiciously followed.

In cases which do not possess facilities for bathing in tubs this sheet bath furnishes a good substitute for the full or partial baths to be described later. They may be given upon a cot or upon a blanket-covered table, or on the floor near the bed to avoid wetting the latter. In rural districts or in poor families great advantage will thus accrue to the patient, who may, if necessary, be deluged with water in this way.

In all febrile affections with high temperature, except in chest or abdominal diseases, this bath is applicable. In the exanthemata, when high temperature, with or without stupor and cyanosis, gives evidence of "suppression" of the eruption, the sheet bath with its attendant frictions is an admirable remedy, having the advantage over medicinal antipyretics that it stimulates the heart, deepens the inspiration, and increases oxygenation and diuresis, thus fulfilling other very important indications besides temperature-reduction. He who has seen a child with scarlatina tossing and moaning with a temperature of 104° or more, with mottled skin and shallow breathing and decreased urine, cooled and refreshed and enlivened by this bath, will never forget the relief and satisfaction derived from so simple a procedure.

In chronic affections, when the patient is too feeble to take the dripping sheet, this bath may be administered.

In feeble patients, partial sheet baths, made by placing fringeless towels over the trunk and treating it in sections as above described, will prepare the case for the full sheet bath or relieve local internal hyperæmia if applied over the affected part.

The flexibility of the procedure is self-evident. Modifications to fulfil various indications will suggest themselves to the physician who masters its rationale and objects.

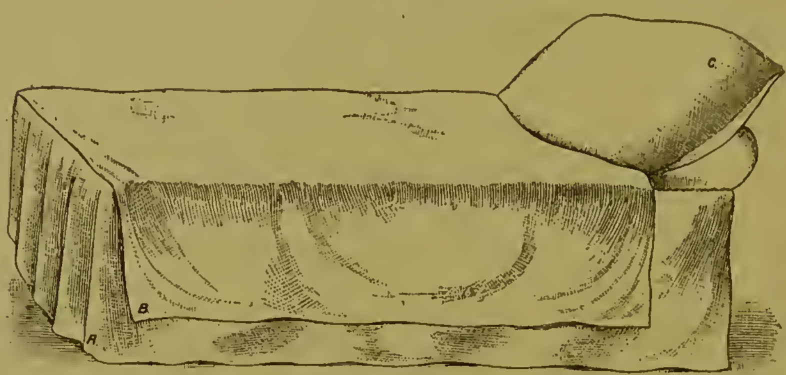
The Wet Pack.—This application of water by means of a linen sheet is not, as is usually believed, the invention of the hydropaths, but was first suggested by Lucas, an English physician, in 1750.

Just as we modify the effect of powerful medicinal agents by the method of administration, so may the effect of water be modified, except that the changes which may thus be wrought are more numerous and the effects more striking.

The wet pack is *not really a wet sheet*, but a *damp sheet*, by the application of which we aim to envelop the patient in a vapor-bath of his own creation. It is applied as follows: A good blanket is smoothly placed upon a cot which has been covered with a hair mattress. A coarse linen sheet—or a linen tablecloth may be substituted, because of its being more apt to be found in most households—is now dipped in water varying from 70° to 50°, as may be indicated, always beginning

with the higher temperature and lowering it from two to six degrees daily. This sheet is now wrung out more or less according to the object

FIG. 129.

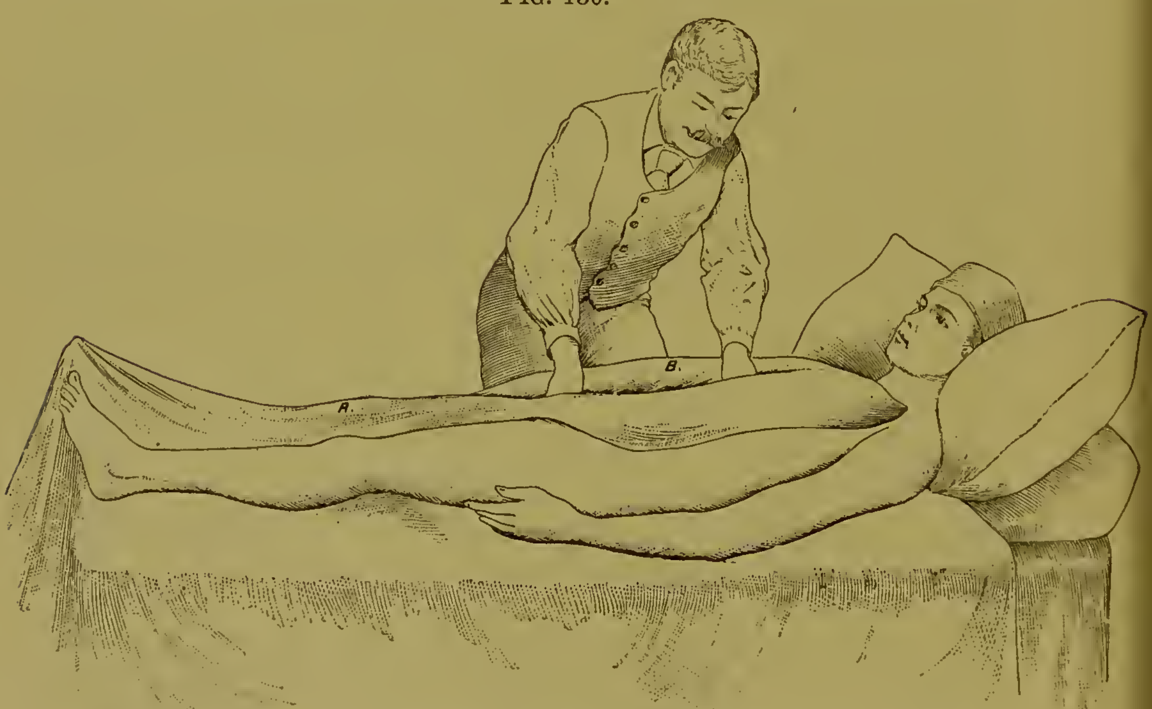


Cot prepared for Wet Pack. *A*, Blanket. *B*, Damp Sheet. *C*, Pillow.

in view, and is then opened and spread as smoothly as possible upon the blanket. (See Fig. 129.)

The patient, having a wet napkin or a soft towel pinned over his head, is laid upon the sheet, so that its upper border touches the nucha. The attendant now rapidly envelops him in the sheet, taking care that no two surfaces remain uncovered in approximation. and that he does

FIG. 130.

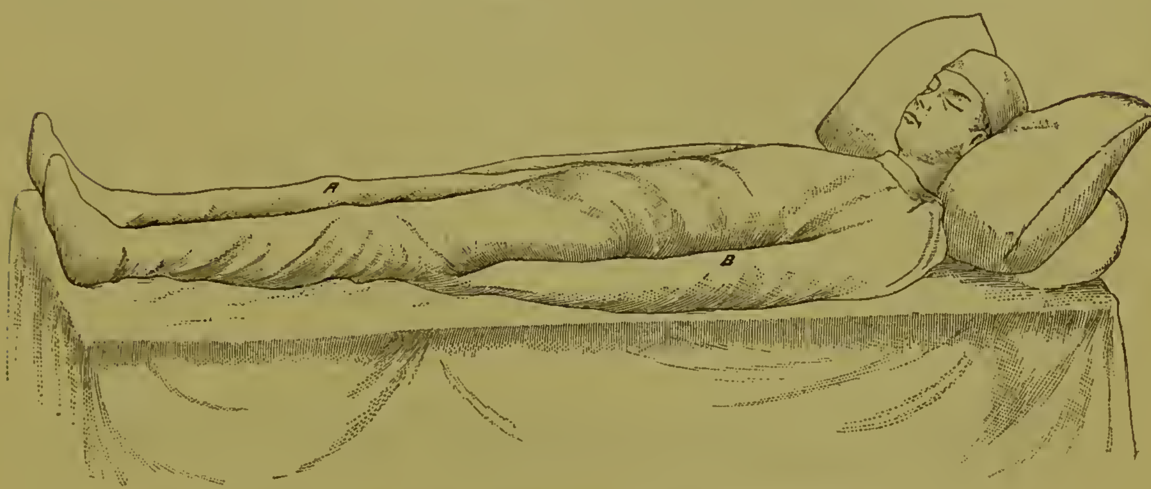


Wet Pack—First Stage. *A*, Damp Sheet. *B*, Being pressed between the right arm and body.

not sacrifice comfort to neatness. Fig. 130 shows the sheet lying over the right side of the patient's body, its edge upon the chest and abdomen, while the attendant presses some folds down between the arm and body.

Fig. 131 shows the sheet folded over the entire body, the folds being pressed between the arms and body and between the lower extremities.

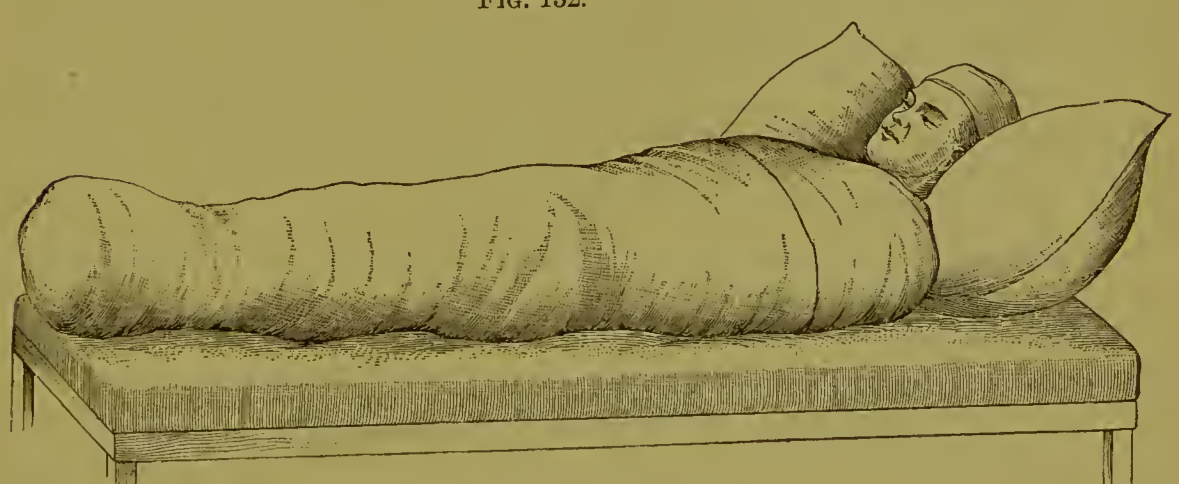
FIG. 131.



Wet Pack—Second Stage. *A*, Damp sheet between legs. *B*, Sheet folded between body and left arm.

The sheet thus having been snugly applied, and secured at the neck, with care not to embarrass respiration, and below the feet, the patient

FIG. 132.



Wet Pack complete on Cot.

is completely covered by the blanket in the same snug manner. Figs. 132 and 133 show the pack complete.

This is called the full wet pack, which may be modified by including only the trunk of the body—trunk packs—or its upper part alone. The length of time in which the patient should remain in it is from half an hour to an hour. If given for the *antipyretic effect*, the sheet should not be so thoroughly wrung out as if for the vapor-bath, and the pack should be changed every ten minutes until the necessary result is achieved or the first signs of deficient reactive power ensue.

The object of the wet pack in chronic diseases differs, as will be

shown, from that aimed at in acute pyrexiæ, hence the modification in technique referred to. It is always advisable to open a window while the patient is in the pack, closing it before he is unwrapped.

The use of the wet pack depends upon the following facts: The

Fig. 133.

Wet Pack on Bed. *A*, Wet towel on head.

difference of temperature between that of the body and of the damp sheet produces the effect of a sudden shock to the peripheral sensory nerve-endings. The result, as has been previously indicated, is a contraction of the cutaneous vessels and the driving of blood from them into the underlying vascular area, chiefly the muscular twigs. This stage lasts, however, only a short time, according to the age and vigor of the patient, his sensitiveness, and his power of reaction. A chill rarely occurs a few minutes after the wrapping, especially if a glass of cold water be given him, and the current of blood sets in again toward the periphery, whose vessels now begin to dilate. The sheet becomes warmer by the more rapid flow of blood to the periphery, from which heat can be but slowly given off, owing to the bad conducting media with which it is surrounded. Finally, perspiration may occur.

The pulse, which on the immediate contact of the body with the sheet, is accelerated for a brief time, becomes more slow, diminishing often from ten to twenty beats, and rising again toward the termination of the pack, when the body is thoroughly warmed. Max Schueller's experiments on animals, referred to on page 465, show that the vessels of the pia mater become dilated in the cold pack, but contracted after the surface becomes warm. The respiration is somewhat accelerated. The fact that the blood then circulates more slowly through the lungs, although the latter act more rapidly, would point to an increased oxygenation of the blood in the wet pack. The body being practically enveloped in a vapor of its own creation, the skin gives off a good deal of moisture, and with it other matters, if Quirolo's investigations on the elimination of noxious materials through the perspiration in infectious fevers be correct. If the pack is prolonged to several

hours, so long as the sheet retains a temperature below that of the body the continuous flow of warm blood to the periphery excites cutaneous-nerve stimulation, and the process of in- and outflow are repeated, the vessels being subjected to a discipline which is invaluable in some affections, as will be shown.

If the pack cannot be prolonged in chlorotic or weak individuals, who possess feeble heat-productive power, if chilliness becomes pronounced, and warmth does not succeed it or is followed by chilliness, the wrappings should be removed. Such individuals may have their reactive capacity assisted by active friction or other heating procedures prior to entering the pack. It is an error, however, for that reason to raise the temperature of the water in which the sheet is dipped. *It is a law in hydrotherapy that the nerve-stimulus (hence the reactive power) is enhanced by the intensity and brevity of the application.* A sheet wrung from water at a temperature of 60° in a patient who has been previously warmed up (not by active exercise, however) will bring on reaction much sooner than one wrung out of water at 80°. A coarse sheet, well wrung out, is here indicated.

The wet pack calls out all those physiological effects which have been referred to in the first part of this essay—viz. a heightened functional activity in the nervous and muscular systems, and consequent enhancement of the processes contributing to nutrition and tissue-change. In addition to these, the quiescence which follows the commotion induced by the first stimulus of contact, and the subsequent equalization of temperature between the body and the surrounding media, furnish an important therapeutic agent. Probably, through removal of the acid fatigue-products, this passive state of the nerve-centres is enhanced; hence many sleep in the pack, an evidence of its calming effect. This reduction of functional nerve-activity in the muscular and nerve-tissues prepares them for recuperative processes, since, according to Ranke, these structures receive nutritive elements chiefly if not entirely during a state of comparative inactivity.

The enforced rest for one or two hours produces a favorable influence also upon the hyperæsthetic condition of some neurasthenic and hysterical cases—a discipline which may be rendered therapeutically valuable by judicious modifications adapting it to each particular case.

THE WET PACK AS AN ANTIFEBRILE AGENT is here separately considered, because its technique is quite distinct from that just described, which is chiefly used in chronic affections. In febrile diseases we have no remedy that will refresh the patient more than this, and render him comfortable. If the temperature is high, say 103° or higher, the sheet is wrung not entirely dry out of water from 75° to 60°. The patient is wrapped precisely as in the method just described, except that the blanket may be lighter and no additional bed-clothing

be heaped upon it. So soon as the enveloping sheet feels warm upon the chest, another blanket and sheet wrung out of water of from two to five degrees higher temperature are prepared on the opposite side of the same bed or upon another near the first. The patient is wrapped within these, and again removed into a third as soon as he warms up the second. This is continued about every ten minutes until from five to eight packs have been given or the sheet ceases to warm up rapidly. A prolonged *chilliness is a positive signal for cessation* of the pack. The true antipyretic effect of the wet pack has been carefully studied by Liebermeister, who declares that five packs of ten minutes' duration are needed to produce the same antipyretic result as one full bath at 65° F.

This method presents a mild form of hydriatic antipyresis, which may not be objected to by the patient and friends as much as the full bath. It becomes, therefore, an important measure which may be utilized as a preliminary to introduce more heroic treatment.

All wet packs must be succeeded by some procedure which checks the relaxation of the cutaneous vessels and restores their tone. This is a rule which the scientific as well as the empirical hydrotherapists insist upon. After the process of packing is finished, then in chronic diseases, when the patient is fairly strong and able to move around, his feet are freed from the blanket and also loosened somewhat and encased in slippers. He now walks or is carried to a tub half full of water at from 70° to 60°. The blanket and sheet are rapidly removed by the attendant, and the patient bathes his face and chest in the water and seats himself in the tub. The attendant now dashes the water upon his back and shoulders by means of a little pail or basin, while he does the same with his hand upon the chest and abdomen and practises friction upon his extremities. After from three to eight minutes he is removed and thoroughly dried.

In febrile cases or in cases of debility a simple ablution with water at 50°, followed by friction or a sheet or towel bath, which will be presently described, may terminate the packing. This is a repetition of the stimulation of the cutaneous vessels, their contraction and subsequent dilatation, and the ebb and flow of blood from and to the periphery. In chronic cases this *finale* is an additional stimulus to tissue-change or to absorption of pathological products; in acute diseases the antifebrile effect is heightened by this half bath or by the cold ablution.

As a discipline for the nervo-vascular and glandular apparatus of the skin it is the most useful method. The so-called hardening effect is marked as a protection against colds and catarrh, and the restored tone of the cutaneous nerves offers an important adjunct in the management of depreciated neurotic patients. Usually the appetite improves

strikingly, sleep is promoted, and general robustness results after a longer or shorter continuance of this method.

Partial Packs in the form of damp compresses may be used over inflamed or hyperæmic parts. These are well known in the treatment of asthma, of pulmonary troubles, of congestion of the abdominal viscera and glands, or in other hyperæmias. In all but the last two cases they are applied as stimuli to the superficial vessels lying over the inflamed parts. If the cloths are well wrung out of water at from 60° to 50°, the first impression of cold passes rapidly away, and is followed by a pleasant warmth due to the superficial hyperæmia. These compresses should lie upon the parts snugly, and be covered with flannel to retard evaporation and escape of heat until they are nearly dry. They should be renewed after the part has been rapidly bathed with cold water, and repeated as often as necessary. We possess no more soothing, calming, and derivative absorbent agent. In superficial inflammatory affections the linen compress should be thinner, not wrung out so completely, and not covered, and be more frequently repeated. When the object is to reduce local hyperæmia, a better plan is to lay single strips of linen upon blocks of ice and apply them frequently to the inflamed part. In purulent conjunctivitis, for instance, in threatening phlegmon, in contusions, sprains, and cutaneous inflammations, this method of applying cold has been found eminently useful. It should be observed, however, that if reaction is allowed to follow each application of the iced cloth, its object would be defeated—*i. e.* the constringing effect. Hence frequent continuous repetition is a *sine quâ non* in this instance, while in other cases the pack or compress must be prolonged until it is nearly dry, to obtain the superficial relaxing effect from the vapor-bath produced by it prior to the application of the terminal cold.

The Abdominal Compress is one of the most valuable of the local packs. It is made by forming several folds of a coarse linen towel of sufficient breadth to reach from the ensiform cartilage to the pubis, one of which is then wrung out of cold water. After this is applied the remainder is rolled around the body so as to retain snugly the position of the first, or four folds of coarse linen wrung out of cold water are applied and secured by a flannel bandage.

The Therapeutic Indications for the Wet Pack may be found in most subacute or chronic diseases involving faulty tissue-metabolism and consequent or coincident deposit and afflux of pathological products to parts.

In chronic articular rheumatism, especially if accompanied by anæmic manifestations, in muscular rheumatism, gout with or without deposits, in catarrh of the gastric or intestinal tract, the indications for the wet pack of an hour's duration, followed by a rapid cooling pro-

cedure, will be plain to the reader who has carefully studied its *modus operandi*. In the above-mentioned affections many positive curative changes have been attributable to this procedure, in the observation of the writer, after his failure with all the most approved medicinal and non-medicinal remedies. Precise rules for the management of such cases cannot be laid down in this brief article, nor are they necessary if the *modus operandi* is understood.

In cases of anæmia undoubted effects in the improvement of the condition of the blood, as evidenced by the general aspect of the patient and from hæmometric observations, have been recorded by the author, as well as by many writers on the subject.

In phthisis, when the heart is irritable or excitable, there is no more powerfully calming measure than wet packs of the whole body until it is moderately warm again—that is, from one-half to three-quarters of an hour—followed by a rapid cool rain-bath. Professor Winternitz speaks highly of chest compresses, prepared with napkins folded in a triangle, which after being well wrung out of cold water are applied so that the apex of the triangle lies over the ensiform cartilage, while the other corners are respectively folded over the shoulders; or it may, in the event of the posterior portions of the lung being involved, be placed over the back. Or a wide roller of linen may be wrung out of water and applied in a figure-of-eight over the entire chest. All these must be covered by flannels.

Winternitz claims that the vapor from the damp cloth and the uniform heat evolved from it produce a condition favoring organic processes. He regards the constantly enveloping gentle warmth as acting beneficially in evolving reactive inflammation, limitation, separation, absorption, or cure of diseased tissues.

In hæmoptysis the application of cold compresses frequently repeated upon the front of the chest is useful, because they deepen respiration, thus preventing stasis, and act as local soothing measures.

In acute croupous and catarrhal pneumonia the local chest-pack is an invaluable measure. A linen compress, three- or fourfold, should be applied with care, well wrung out of water at 50°, and covered by a flannel or stout cotton bandage to prevent dampening of the patient's clothing. The latter would seriously defeat the object, as any experienced nurse knows. Care in applying it without too much disturbance of the patient is important. The compress should be changed every half hour if the temperature be high. Besides his own clinical experience, the author may cite so good a teacher as Felix von Niemeyer,[1] who says: "It has been of great interest to me that both Bartels and Ziemssen strongly commend the application of cold com-

[1] *Textbook of Practical Medicine*, translated by Drs. Humphreys and Hackley, D. S. Appleton & Co., 1875, p. 195.

presses to the chest, as proposed by me in croupous pneumonia, as by far the most efficient treatment."

When the temperature is high and the pulse and respiration are very rapid in the early stages of pneumonia of children, the full wet pack is indicated. Its soothing effect is marvellous. That it requires some courage on the part of the uninitiated to wrap a child with pneumonia in a sheet wrung out of water at 65° a recent experience of the writer illustrates. While in the act of doing so the anxious father expressed his feelings by saying to me: "Doctor, this seems like heroic treatment, but we trust you." My reply was emphatic when five minutes later I pointed to the child which had been tossing in great distress all night, and who was now slumbering peacefully, its cyanosed features having become calm.

In all febrile conditions from whatever cause, especially when high temperature with enfeebled circulation is present, wet packs are calmative, not only reducing temperature, but soothing nerve-erethism and aiding in the diminution of effete material by stimulating the heart and encouraging diaphoresis and diuresis. The medicinal antipyretics do not fulfil so many indications, but owing to the greater simplicity of their administration may be preferred in all non-infectious fevers.

Strümpell, whose work, translated by Shattuck of Harvard University, is now a textbook in our best colleges, says (page 173): "In the treatment of lobular pneumonia of children the best remedies are tepid baths with affusions and general wet packs applied several times a day. The higher the fever is, the oftener must these be repeated; with moderate fever the child may stay in the pack for two or three hours."

Drs. J. Kaufman and Baer[1] give some exact investigations made in Kussmaul's clinic on wet packs and compresses in pneumonia. The temperature of the water was from 59° to 68°, and the patients were entirely enveloped for half an hour—longer if they felt comfortable; which is the custom in Kussmaul's clinic in cases of the exanthemata. Almost without exception the patients felt pleasantly during the cooling, and much relieved afterward; dyspnœa was diminished, and often the most restless patients were calmed into slumber. Although the temperature was not much reduced, the object achieved was a powerful derivative to the skin with all its beneficial results. In most cases the blood-pressure was increased at first, but quickly considerably reduced, as measured by Busch's instrument, while the pulse was reduced in some cases and not in others.

In cases of acute nephritis, in which Kussmaul had often seen in his consultation practice serious dyspnœa with bad, even lethal, results from hot baths, the cold wet pack acted far differently. The subjective

[1] *Berlin. klin. Wochenschrift*, July 9, 1888.

condition of the patient was greatly improved, an energetic derivative to the skin was instituted, and if the patient was afterward covered with a blanket energetic perspiration ensued. The blood-pressure was regularly diminished by the packs, and returned very late to its original height.

In cholera infantum and summer diarrhœa, when decided pyrexia is present, the abdominal wet compress is far superior to poultices, which are so much in vogue, because they dilate the cutaneous vessels quite as much by the reaction they induce, and thus promote any probable derivative effect, while they are equally soothing and aid in reducing elevated temperatures.

The Hot Wet Pack.—In this connection a method may be referred to which, though it has a limited application, is invaluable. Instead of wringing the linen sheet out of cold water, it is dipped into water at 110°, well wrung out and spread upon the blanket, as in the cold pack. The patient is wrapped as in the latter, and allowed to remain for an hour. He is now rapidly removed to the side of the bed upon which he is to lie, lightly rubbed over with a rough wash-rag squeezed out by the hand, dipped into water at 65°, quickly dried, and left alone.

This method in the author's practice has been found useful only in obstinate insomnia. Its effects are explicable upon the evidence of Max Schueller's experiments on rabbits.

The Hot Blanket Pack is a procedure that has long been utilized by physicians not otherwise familiar with hydrotherapy. It is prepared by placing a rubber sheet and one or two woollen blankets upon the bed. A heavy woolen blanket is now wrung out of water at 110° by two persons twisting it in opposite directions. This is spread upon the dry blanket and rubber sheet, the patient placed upon it and wrapped with it like a mummy. The dry blankets and rubber sheet are now wrapped over the damp blankets, and the patient is allowed to remain in this pack from half an hour to two hours. By this means the superficial vessels are at once dilated, and continue so under the influence of the artificial vapor. The functional activity of the skin is increased, perspiration ensues, and peccant matters are eliminated. The superficial hyperæmia acts as a general poultice and as a derivative from the viscera. Tension of the blood-vessels is decreased and a general relaxation ensues.

The Therapeutic Indications for the Hot Blanket Pack are numerous. In suppression of urine the writer has obtained marked effects from this pack. In cases of uræmia it is a resource which should not be omitted, and this fact is testified to by numerous clinical records. The most recent of these is that of B. C. Hirst,[1] who records two very

[1] *University Medical Magazine*, July, 1890.

severe cases of eclampsia during and after labor at the Maternity Hospital in Philadelphia, which, apparently beyond hope, yielded in an astonishing manner to the profuse diaphoresis following a hot wet blanket pack after other remedies, including venesection, had accomplished nothing.

Local Hot Packs.—These are prepared by wrapping the patient in a dry blanket, and applying old pieces of blanket of sufficient size well wrung out of water at as near the boiling-point as possible. The latter is done by using a clothes-wringer or a piece of stout canvas half a yard square, to two of the sides of which handles are secured projecting beyond the upper and lower edges. The hot, wet pieces of cloth are laid upon this wringer, which is now twisted in opposite directions by its handles. Care should be taken that every particle of unabsorbed water be squeezed out, for only by this means may scalding of the parts be avoided. If they are well wrung out, the attendant may handle them with impunity : he applies them to painful parts by raising the enveloping blanket, and again secures the latter snugly. Thus a constant hot vapor is created under the blanket, which produces profuse diaphoresis; the direct heat from the wet cloth produces hyperæmia over the affected parts, and thus relieves local pains. These applications are frequently renewed for from half an hour to an hour, until the patient is in a profuse perspiration. He is now quickly dried; receives a rapid ablution with water at 65°, is dried, and placed on the side of the bed he is to occupy.

The therapeutic indications for this method explain themselves. Its chief application is in rheumatic and neuralgic affections. In recent lumbago and sciatica I value these applications above all other external or internal remedies. They require skill on the part of the attendant. I have seen one bad case of scald produced by imperfect wringing.

The Dripping Sheet.—This is a perfectly distinct procedure from the wet pack, and, as it is frequently confused with the latter, its description follows most usefully at this point.

My experience having been originally with the greatly depreciated patients at the Montefiore Home, I devised a method which I have retained in more robust cases. To avoid the chilling effect of cold water upon the feet, the patient is placed erect in a tub containing twelve inches of water at 100°. A linen sheet, the coarser the better, is now dipped in water at 70°, which is reduced daily two degrees until 48° is reached. This is thrown over the patient from behind, covering the head and body, so that it clings to the latter (Fig. 134). The attendant now makes rapid passes with both hands, beginning anteriorly and posteriorly, so as to produce friction and afflux of blood to the surface, increasing the surface irritation by occasional gentle tapping and slapping with the outstretched hands. When parts of the body feel warm

to the attendant's hands, cold water at from 40° to 70° is thrown upon them from a basin or cup and friction is renewed.

Another method is executed by wrapping the sheet from the front, around the patient's body alone, while he stands with outstretched arms. Placing the left upper corner under the patient's right axilla, he secures the left edge by holding it with the arms against the body, while the attendant carries the right edge under the left axilla, the patient now replacing this arm alongside the body, and then, carrying it over the back, throws it across the right shoulder, and thence around the neck and upper chest to the left, where it is tucked under. The patient's arms being uncovered, he aids in the friction in front.

Fig. 134.

Dripping Sheet.

Great care should be taken in feeble patients to make the friction mild, in high states of pyrexia to use a finer sheet and more and colder water, and in chronic cases to use a coarser sheet and less water and more active friction. It must always be borne in mind that it will make less demand upon the patient's vitality to apply a sheet wet with water at 60° than at 95°. By shortening the duration and producing friction, reaction will be favored when the lower temperature is used. After the dripping sheet the patient should be rapidly dried, and if able should be sent into the open air; if not, he should be well covered and the windows opened, in order to obtain the full advantage of the deeper inspiration.

The *rationale* of the dripping sheet is explicable upon the general principles above referred to. The sudden cold impression upon the entire body stimulates the peripheral nerves actively. This stimulus results in a reflex action. The blood is driven from the superficial vessels, only to return quickly wherever the friction-producing hands dilate them. Hence an active vascular ebb and flow is constantly in operation, which relieves internal hyperæmia, removes vascular tension, relieves the heart if embarrassed, reduces the pulsations, and invigorates its muscular tone. Respiration is greatly deepened from the moment the cold wet sheet strikes the large surface exposed to it. The inspiration being deepened while the blood circulates more slowly through the lungs, oxygenation with all its advantages is enhanced.

Therapeutic Indications.—This most powerfully stimulant procedure, rendered more so by the assistance of the attendant, is useful in anæmia and chlorosis, in which an improvement of the cutaneous circulation is so imperatively demanded, and in which tissue-metamorphosis must be promoted. In all chronic diseases in which the blood-making function is defective the dripping sheet is one of our most valuable resources. In phthisis I have found this the most useful of all procedures when properly adapted to the case, and when the latter has been prepared for it by hydriatic procedures of gradually increasing intensity. It should always be adapted to the patient's reactive capacity; the room should be warm and all the preparations for rapid drying be made before he is subjected to it. There is no advantage in a higher temperature of the water than 70°, because even the most feeble will, if properly prepared, react better if the temperature is lower. The effect may be enhanced by a dry pack preceding it, which accumulates heat upon the surface, and thus precludes the removal of any internal heat from an anæmic patient.

In acute exanthemata, when the temperature is rising and there is evidence of sluggish circulation in the slowness of the eruption, the dripping sheet, with active but gentle friction, will "bring out the rash" by equalizing the circulation, relieving the heart, and deepening the breathing.

In feeble digestion, in chronic catarrh of any organ, in visceral engorgements or infarctions—in short, in all diseases in which a refreshed circulation and innervation may lead to a "renewal of life," as Dr. King Chambers aptly expressed it—the dripping sheet is the procedure *par excellence.*

The Half Bath.—This is prepared in a tub containing about eight or ten inches of water of such temperature as the case in point demands. The pressure of the water is thus avoided, that the attendant may more readily practise douching and friction. A wet towel being tied around his head, the patient is seated in the tub; the bath water is poured and dashed over his back, head, and shoulders with the attendant's right hand, while he practises friction with the left, and the patient does the same on the anterior portion of the body. Occasionally the patient dips his whole body into the water for a minute or two, while the attendant continues the friction. The temperature of the bath water may be lowered if a more decided impression is desired. The bath is continued for from five to twenty minutes, the patient and attendant continuing active friction. By these measures there is a constantly recurring shock and reaction. The lower the temperature in this bath, as in others, and the more brief the cold application, the more active will be the stimulus and reaction. Winternitz regards

the half bath as far more temperature-reducing than even a colder full bath without motion. The active and unimpeded friction operates favorably as a heat-abstractor; heat is given off to the water and chilling is prevented. If coma or delirium is present, this bath produces an awakening effect upon the nerve-centres by permitting of affusions from some height. The duration of the half bath should be from ten to thirty minutes, and the temperature of the water in high fever should be from 60° to 75°, using the higher temperature of water on the lower part of the body, and the lower temperature on the higher portions of the body. If, however, the reaction is likely to be sluggish, the lower temperature is far more useful, if *briefly applied* with good friction and douching. The skin must show some bright redness, not a dark mottled hue. The efficacy and pleasant effect of the half bath depend upon the skill and judgment of physician and attendant.

Winternitz dwells upon the effect of properly-executed half baths upon respiratory difficulties. In pneumonia with exudation, dyspnœa is relieved or cured when the skin has been made hyperæmic by a good half bath with affusions.

The principle of peripheral vascularization referred to in the therapeutics of the full bath is worthy of careful attention in the treatment of the now too-often fatal pneumonia. If the theory is correct—and I have little doubt of it—that the right ventricle may be unloaded, and thus relieved by vascularizing the large cutaneous area, we have in the half bath a powerful agent to counteract heart failure and improve oxygenation of the blood.

In all fevers involving a depreciated nervous system, as manifested by ataxia, delirium, and even coma, the half bath is indicated.

In chronic affections the indications are numerous. The half bath, offering all the advantages of other hydriatic procedures, may be resorted to as one of the changes which impress the patient. In constipation Winternitz recommends buckets of water to be thrown from some height upon the patient's abdomen while he lies in the water. After the bath he is quickly dried and rubbed and ordered to exercise in the open air. In Winternitz's establishment at Kaltenleutgeben, I have seen the half bath used more frequently than any other procedure. He applies it with success in chronic inflammatory conditions of the spinal cord, at a temperature of from 74° to 86° F., the latter when lancinating pains are frequent and intense, of eight to ten minutes' duration, without friction. The body is gently kneaded in the water and the back is simply bathed. When the pains diminish the baths are made cooler and shorter. The anæmic condition due to compression of the vessels by exudation in the diseased parts is relieved by the not too forcible vascular interchange resulting from such a bath. Eulenberg and Charcot having demonstrated reduced tension of the

pulse in ataxic patients, these baths, if cautiously given, serve to counteract these conditions and improve local nutrition.

The Full Bath.—This consists of a tub about two-thirds full of water, the duration and temperature being adapted to the purpose in view. It differs from all other hydriatic procedures by reason of the more prolonged contact of the nude body with a large amount of water. It is well to suspend an inflated air-cushion from the head of the tub for the head to rest upon, and a water-filled cushion may be placed on the bottom of the tub to receive the nates. Thus the patient's body may be entirely covered by water, so that his chin just clears it.

The Brand Bath.—In acute diseases, in which this bath is usually applied, and in which the patient demands the utmost freedom from physical and psychical disturbance, a screen should be placed between the bed and the tub to prevent him from witnessing the preparations. The tub should be on rollers, so that it may be filled in or near the bath-room and thence conveyed to the bedside.

While the patient is in the bath a blanket should be spread upon his bed, and upon this a soft linen sheet and a towel under the head-piece. Hot bottles or bricks, wrapped in stockings or pieces of blanket, should be in readiness to warm the feet, which not infrequently remain chilled after a full bath.

Before the patient is placed in a cold full bath a stimulant ($\frac{1}{2}$ ounce to 2 ounces of brandy) may be administered. The sexual organs are lightly covered by a napkin, the face and chest are laved with ice-water, after which he is gently placed in the water. The shock of the cold submersion may cause the patient to declare that he cannot breathe, or it may produce trembling. Usually, if the temperature is below 70°, he will remonstrate with the attendants that he is very cold and that he cannot bear it, but patience and avoidance of flurry or excitement, firmness in insisting that no harm shall befall him, and extreme gentleness, will overcome his objections.

It would be well to avoid sympathetic bystanders, who will by the expression of their faces or by actual remonstrance defeat the proper execution of the procedure. The latter requires the courage of conviction derived from actual practice or careful investigation, so great is the temptation to obey the importunities of the patient and his friends. After the patient is submerged one or two persons should gently pass the flattened outstretched hands over successive parts of the body. By these frictions, as Ernst Brand of Stettin, the originator, has shown, the superficial cutaneous vessels are dilated, and because of the reaction induced by it the skin, which was of a dead white when the patient entered the bath, becomes of a ruddy hue under the hands. It may become cyanotic if friction does not actively counteract the contraction of the arterioles produced by the cold impact. The patient must not

be removed until the allotted time has expired. The best guide to the safety of the bath is the patient's condition. If he complains of being chilly or shivers, he must not be removed until chattering of the teeth confirms the statement. Cyanosis of the lips or face is an immediate signal for removing the patient to his blanket. Many physicians are deterred from continuing the baths sufficiently long (fifteen minutes, according to Brand) when the pulse becomes small and thready. But this is due to the local effect of the cold upon the radial arteries. *Unless the thready pulse is accompanied by an increased number of beats, danger from collapse is not present.* Frictions over the body and limbs should never cease during the bath.

When fifteen minutes have expired, or the patient's condition demands it, he must be gently lifted by two persons, and be held suspended for a minute over the tub while the superfluous water drains off and the napkin is removed. He is now laid upon the sheet, and quickly wrapped from head to foot. If the temperature has been above 103° F., he is covered with the blanket and dried in five minutes; if below 103° F., he is dried with the sheet and towels, his gown replaced, and he is covered by the bed-clothes, hot water being applied to the extremities. At this point nourishment is most readily administered.

The Graduated Full Bath.—This method was introduced by Von Ziemssen, the editor of the celebrated *Cyclopædia of Medicine*, as a modification of the Brand bath. It is better adapted, he claims, for private practice when patients object to the sudden entrance into cold water.

Preparations are made as in the bath just described, except that the tub is filled sufficiently to cover two-thirds of the recumbent body. The water being warm, no shock ensues. The continuous dashing of water upon the body by the attendants, and the gradual lowering of its temperature by the addition of cold water (ice-water may be used if a rapid change is desired) while warm water is being removed, constitute the difference between these baths. Friction is practised, as in the Brand bath. As the graduated bath lasts half an hour, and the water is reduced to 68° as rapidly as possible, the patient really lies quite as long in cold water as in the Brand bath.

The mode of action of the full cold bath is explicable upon the general principles laid down. The thermal stimulus is intense, there being a difference between the temperature of the body and the water of from thirty to forty degrees. The active cutaneous circulation in the early stages of fever protects the patient against injurious effects. If the submersion is brief or if muscular action during submersion could be maintained, as it is after Turkish baths, no harm can ensue. But in fever cases the lack of tone in the vessel-walls seriously impairs reactive

power. Hence frictions are of the utmost importance. Without them much harm may be done, and to their neglect is ascribable much of the prejudice existing against the cold bath in fevers. I well remember a case at one of our large hospitals in which the temperature was reduced from 106° to 100° by wrapping the patient in a sheet and saturating the latter with ice-water squeezed from a carriage sponge. That the patient succumbed (with a lower temperature) is explicable upon the physiological effect of *such* a procedure. The blood, driven from the contracted peripheral vessels to the interior, was not permitted to return to the surface. Hence the cooling was only a surface cooling, ascertainable in the mouth. As the rectum shows one or two degrees higher in many cases, because the mouth is more superficially situated, so may the rectum temperature be depressed still lower by such positive cooling without indicating a lowered temperature in the deeper tissues. How much more rational is the Brand bath, which by continuous chafing of the surface stimulates the cutaneous vessels to dilate, filling them with blood, as is indicated by the suffused redness seen under the chafing hand! The blood is cooled in these dilated vessels, and rapidly carried into the interior to be exchanged for hot blood coming from within. This interchange produces a cooling of less intensity than the continuous chilling of the surface in the bath without friction, but it is more positive and enduring.

Aside from this palpable effect, we have the authority of Leyden, Traube, and others that the rise of temperature in fever is in part due to diminution of heat-dissipation from the surface because of partial paralysis of the arterial coats. Friction, as Weyrich has proved, increases water-elimination, and it, together with the stimulus of cold, overcomes the paresis, and thus increases heat-dissipation. The nerve-centres receive not only the refreshing impressions from the surface, but they are directly supplied with cooled blood, and thus their functions are approximated more to the normal, and the organs depending upon them are favorably influenced. The rapid pulse, indicating that the heart is struggling to overcome the effect of enfeebled innervation, is reduced. The heart, which has been laboring to compensate for the loss of assistance from the contractility of the arterial coats, which Marey and Winternitz have shown to be in abeyance in infectious fevers and to be the chief cause of heart failure, is relieved, because the superficial arterioles are stimulated to alternating dilatation and contraction by the chafing and subsequent impact of cold water.

Thus, all the indications in the treatment of fever are fulfilled: the temperature is reduced, the nerve-centres stimulated and refreshed, and the integrity of the organic functions maintained.

In chronic diseases the cold bath is utilized as a plunge after heat-elevating procedures, combined or not with swimming exercise; and so

we have the mechanical action of the volume of water and the increased pressure upon the peripheral vessels, which must increase the pressure within and improve the force of the heart. Reaction is increased by this active disturbance of circulatory conditions: there is increased tissue-change and the temperature is elevated. If it is continued too long without muscular movements or friction in a patient not having an elevated temperature, the lips and skin become cyanosed, the face and extremities become pallid, cramps and chills ensue, and serious consequences may result, which an active muscular movement would prevent.

The shock from the thermic contact in the plunge is somewhat similar to that of the douche.

The therapeutic indications of the cold full bath must be considered separately, because this bath has a distinct history which is as remarkable as it is unappreciated.

TYPHOID FEVER.—Without entering into details, it may be stated that to Ernst Brand we are indebted for an earnest, intelligent, and courageous effort to introduce to the profession this treatment, which had since the day of Hippocrates passed through many vicissitudes, again and again appearing under the ægis of some noted men, like Hahn, Boerhaave, Hufeland, Currie, and others. It is nearly thirty years since Brand, unknown at that time outside of his private *clientèle* at Stettin, published his work on the *Hydrotherapie des Typhus.*

In order to exhibit the true claims of this method, and render it more clearly appreciated, I cannot urge too energetically the fallacy of regarding a high temperature as the chief danger in typhoid fever. Until this fallacy is laid away among the rubbish of pathology, fever treatment will continue to be unsuccessful. Let me not be understood as espousing the idea that the elevation of temperature is of no consequence, or to claim that it is a conservative process. Far be it from me to utter such absurdities. The elevated temperature is but one symptom; it is not in itself a dangerous one. This is evident from the enormous rise of temperature physicians in the South so often observe in malarial fevers without evil results, from the same comparative innocuousness of excessive temperature in recurrent fever, and in the aseptic fever so ably described by the lamented Volkmann and other surgeons. Professor Welch has shown that animals may be kept at high febrile temperatures for three weeks without manifesting serious symptoms. The respiration and pulse were quickened, but the arterial tension remained unchanged. The real dangers in typhoid fever are due to the effect of the toxic agents circulating in the blood, plus the high temperature, and not the latter alone. Were the high temperature the chief element, we would find a specific therapeusis in the powerful antipyretics, whose action is as reliable as is that of veratrum viride

on the pulse. The idea that inflammatory diseases could be effectively throttled by venesection or by the pulse-reducing veratrum was short-lived, because it was based upon the one symptom alone. It may be justly argued that the combating of another symptom—elevated temperature—is equally fallacious. Those who practised venesection knew well what comfort it afforded: the throbbing head, the insatiable thirst, the wild raving, ceased as if by magic. The urine began to flow, the skin and mouth became moist, the patient was calmed into gentle slumber. Lulled into a false security, the life-blood was again and again drained away at a time when its integrity was most essential to the maintenance of the vital powers. What wonder then that an enlightened pathology swept this but too-enduring therapeutic octopus from the field and trampled it into everlasting obloquy?

Shall antipyretics (in typhoid fever) fare better? True, their immediate effects upon the economy are not so disastrous. They, too, render the patient comfortable—they too relieve the throbbing brain, moisten the tongue and skin, and quiet the patient. But they too destroy the living protoplasm by chemical action. They dry up, as Vinay has shown,[1] the fountain whence most of the products of retrograde metamorphosis must issue from the system; they enfeeble the heart and nerve-centres; they destroy the hæmoglobin, as Lepine, Semmola, and Stokvis testified in the Paris Congress of Therapeutics of 1888. Thus they damage those vital processes whose maintenance in vigorous function is really the chief aim of all therapeutic endeavor in typhoid fever.

The chief danger lies in the facility with which they may be administered and the rapid yet positive results which ensue. These are temptations to which the inexperienced physician is exposed, and which he will find it difficult to resist unless he be informed by the investigations and clinical observations of others. The systematic use of antipyretics is therefore as objectionable in typhoid fever as are all other spoliative measures. The chief aim of treatment is to sustain the vital powers until the disease has run its course.

The chief agent in the management of typhoid fever is the cold bath. Practical observations in thousands of well-recorded cases have demonstrated that the systematic application of cold baths has reduced the mortality from typhoid fever to a point below which it will probably never fall. A treatment which shows 1 per cent. mortality in 1223 cases collated from five different sources, including private practice and civil and military hospitals, may be regarded as nearly perfect.

In several papers read before and freely discussed in our medical societies I have endeavored to impress upon my colleagues the true import of the results achieved in Germany and France by the cold-

[1] *Lyon Médical*, 1888.

bath treatment of this disease. Statistics are proverbially misleading when marshalled to sustain a special plea. They may be readily distorted, even by one whose object it is to present them fairly and judicially. In a question of such enormous import as the saving of a human life and the lessening of human suffering it would be criminal to endeavor to sustain preconceived notions by claptrap arguments or fallacious statistics. I have therefore approached this question imbued with the solemnity and import of the issues involved.

Moreover, let it be remembered that I am not advocating the cause of a bantling of my own creation—that I am not striving to achieve fame by the dissemination of my own discovery. As a member of a profession whose highest aims have ever been not only to relieve their fellow-men by direct ministration, but to impart knowledge obtained in the pursuit of the latter, it is my sole purpose to fulfil these aims.

Therapeutic deductions must be based upon theoretical considerations and clinical results. The hydrotherapeutic management of typhoid fever rests on both. In this disease we have an infectious process whose presence is accepted almost universally, although its origin and concomitants are still *sub judice*. Whether it be a process due to the presence of micro-organisms, whose multiplication in the system produces the fever, or a conservative agency by which the disease-germs are to be destroyed and eliminated; whether the local process be the cause or the result of the infection, the latter is manifested by a group of symptoms which unmistakably point to its presence. We have an elevated temperature of characteristic course, accompanied by increased heart-action, with a tendency to feebleness; more or less depression of the nervous system, evidenced by debility, headache, delirium, and impaired digestion, with marked absence of hydrochloric-acid secretion; the skin and kidneys too are crippled in their important eliminating office. That the impairment of all those organs, upon whose functions the maintenance of life depends, may be traced to the toxic agency acting upon the nerve-centres, is pretty clearly demonstrated. We have no more positive evidence of the fact than that presented by the clinical observation that in the treatment of this disease, in which many changes have been made, those methods have been most effective which have aimed to maintain the action of the nervous system in the most vigorous condition. The so-called stimulating and supporting treatment has survived all other methods, because it aims to maintain the integrity of the nervous system, upon which all the vital functions of the body depend. The cold bath has again and again been demonstrated as the most effective stimulant to the nervous system. When a woman faints we have a complete picture of nervous depression affecting the circulation, respiration, and probably all other functions. Is not a dash of cold water

our chief remedy? Is there any medicinal remedy equal to it for arousing the nerve-centres? The first impression results in a deep inspiration; a fresh supply of oxygen is furnished to the blood, which once more courses through its wonted channels, bringing color to the pallid cheek, restoring fire to the glassy eye, and consciousness to the stricken brain.

Trite and simple as this remedy seems, it offers us most convincing proof of the stimulating influence of water upon the nerve-centres. In typhoid fever we have it upon authority which we dare not question that the cold bath refreshes the nervous system; that it deepens the respiration; that it moistens and cleans the tongue, improves the appetite; that it steadies and slows the pulse; that it improves the digestion; that it increases the quantity and improves the quality of the urine; that it removes stupor and delirium. In short, it lends vigor and tone to the entire system, and approximates the condition of the patient so nearly to the normal that his entire aspect is changed. This testimony comes from men like Ziemssen, Bartels, Nothnagel, Hoffman of Leipzig, and other clinical teachers who have cautiously tested and deliberately weighed the results of hydrotherapy at the bedside.

That the cold-bath treatment has survived the onslaughts of prejudice and unpopularity during a period in which so many important developments in medicine have occurred—one of which alone, the discovery of the truly powerful chemical antipyretics, would have sufficed to wreck it—must be conceded as the most convincing test of its clinical value.

The material from which evidence of its surpassing value may be culled is simply enormous. Indeed, no therapeutic question offers so abundant and varied a statistical array of facts. The comparative merit of various methods of treatment is best illustrated by the record of the well-known garrison hospital at Munich, which furnishes us such clear, incontrovertible, bedside observations that it alone may be relied upon to stand as a bulwark of defence against all attacks. Vogl, who is the chief of this military hospital, has been gradually led to the abandonment of all other methods in favor of the strict cold bath by studying the records of his institution for forty-seven years! During this period every known method of treatment had been in vogue in 8325 cases of typhoid fever. The various types of the disease are clearly pictured in his works, as well as its management, from venesection to therapeutic nihilism, with all intermediate methods. As has been the fashion of late, antipyretics and baths have also had their sway.

During the past fifteen years a comparative study of 889 cases shows the results of the bath treatment to be superior to all others, despite the changing types of the disease. The cases not being selected for

either station, the following is the result of the strict bath treatment and a moderate bath treatment combined with antipyretics:

Results.	Strict Bath.	Combined Method.
Mortality	2.7	6.7 per cent.
Average stay in hospital	47.3	40.7 days.
Percentage of complications	68.2	102
Average number of diarrhœas per person per day	0.7	1.9

There is no doubt that these papers of Vogl are the most fair discussion of this question extant. Indeed, it may be justly said that no question in therapeutics has received so complete a survey, inasmuch as we have here a truthful picture of the disease in all its phases, the treatment in all its fashions and forms over nearly half a century, in an institution under constant disciplinary supervision, and among patients of almost the same physical condition, receiving the same diet, and doing the same work. For a comparative estimate of treatment no better data can be imagined. Additional statistics may be offered, but they would only confuse, because they must include old and young, rich and poor, males and females, under varying conditions.

Suffice it to summarize, that while by the combined treatment the average mortality has been reduced to a lower point than ever before—viz. from 40.3 per cent. (1843) to 7.6 per cent.—at times the rate of mortality under this treatment reached almost as high as that of the purely expectant treatment. On the other hand, the systematic Brand treatment—a bath at 65° F. for fifteen minutes every three hours so long as the temperature remains at 103° F.—never allowed the mortality to exceed 4.7 per cent. in the last seven years, and averaged 2.7 per cent. Juergensen reports even a smaller mortality—1 case in 217.

Josias[1] reports 36 cases, of ages from five to forty years, treated with the strict cold bath, with one death in a case which entered on the sixteenth day of a relapse. Dr. J. C. Wilson[2] reports 64 cases treated in the German Hospital at Philadelphia, without a single death,—all by the strict bath of Brand; and Dr. George L. Peabody treated 11 cases by this method in Bellevue Hospital, without a death.

A treatment which in a large number of cases offers us a reduction of mortality to about 3 per cent. in a disease which destroys from 20–40 per cent. of all persons attacked, treated otherwise, demands a trial; and we are guilty of criminal neglect if we permit prejudice, difficulty of execution, or any obstacle to deter us from adopting it. I am convinced that even in the sparsely-settled country districts this treatment may be executed.

If we are not able to obtain a good bath-tub, any large wash-tub may be utilized. The patient is seated in it, half recumbent, with his

[1] *Le Courrier médicale*, Nov. 30, 1889. [2] *Med. News*, Dec. 6, 1890.

feet outside, wrapped in a blanket, while his body is bathed and rubbed as described in the half bath. The following is the practice from which the best results have been obtained: It is of the utmost importance to begin water treatment early, even before the diagnosis is clear. A mild bath can do no possible harm, but is useful in all febrile affections, including pneumonia and the exanthemata. If typhoid fever does not develop, the patient's comfort will at least be enhanced, and his recovery from the less severe form of fever hastened if it does develop. Thus valuable time will be saved. Sponging is inefficient. Ablution is more refreshing; then the half bath, then the graduated bath, and lastly the Brand bath, as described, may follow in succession. Stupor, delirium, and coma always demand the bath if the patient's temperature is below 103°. He is placed in a bath of 95°, and basins of water at 60° are poured over his head and shoulders, until he is aroused or shivers.

The Brand bath treatment and the substitutes and preparatory measures have been described here in detail, because they are applicable to all infectious diseases.

Scarlatina.—In this disease we have the comparative statistics of Dr. Reimer[1] of 3460 cases, treated by various methods, 978 being treated by hydrotherapy. Cold compresses to the head, thorax, and abdomen acted favorably upon the heart, but did not lower the temperature much. Good results were obtained from cold envelopment, combined with affusions of water at 54° to 57° in the empty tub; affusions in a gradually cooled bath were favorable, but sometimes collapse ensued.

The gradually cooled bath did not influence the temperature according to Reimer, and produced general weakness which in some cases was of a threatening character. Such baths had a sedative effect in typhoid fever, but in scarlatina they were pernicious. "The efficiency of full cold baths was undoubted in scarlet fever if they were used methodically and with proper precautions. The patient is plunged into a tub half filled with water at a temperature of from 54° to 57° F. After removing him from the water he must be rubbed briskly and wrapped in a woollen blanket. The temperature frequently drops several degrees; patients are much relieved and desire a repetition. In scarlatina the indications of hydrotherapy vary with the progress of the disease." Reimer regards antipyretic medicaments as attended with danger from collapse.

The testimony of Ziemssen,[2] who quotes Currie's remarkable results by cold affusions in 150 cases, which are equivalent to the sudden and brief dipping of the body into cold water practised by Reimer, is equally favorable. He says: "The most recent times have again proved the high value of hydrotherapy in scarlatina. The energy of

[1] *Archives of Pediatrics*, 1890.

[2] *Pathologie und Therapie des Scharlachs*, 1888.

the water treatment must of course be governed by each case; the earlier the patient comes under treatment, the higher the temperature, and more resisting the organism, the lower should be the temperature of the baths and the affusion. In advanced cases stimulants must precede the use of the graduated cold bath."

Pneumonia.—The therapeutics of this fatal disease have passed through as many vicissitudes as those of typhoid fever. Bloodletting, venesection, and veratrum viride pass before the mind's eye in gaunt and sorrowful procession. Expectancy, too, which rescued us from the foregoing measures, has not even given as good results as in typhoid. Would that another Brand should arise to teach us boldly the use of the bath in this disease! It is true we have already much to encourage us in the writings and statistics of Juergensen, Fismer, Penzoldt, and others. To place these on record here may serve as a nucleus for a future steady advance in the right direction. Dr. A. H. Smith brought before the Tenth International Medical Congress in Berlin the true rationale of the heart-failure which kills in pneumonia, when he not only taught that the right heart is laboring because it is unequal to the extra work, as Juergensen showed twenty years ago, but also that this difficulty may be ameliorated by encouraging and maintaining a dilated condition of the peripheral circulation, and that stimulants alone are utterly inadequate to relieve the heart in pneumonia.

Juergensen recommended very cold baths, preceded by stimulants, and gives some remarkable results. But his heroic treatment has found few imitators. I believe that the *cool full bath*, with friction, meets all the indications, which are to deepen and slow the respiration, reduce the temperature, invigorate the heart, stimulate the nerve-centres, and *dilate the cutaneous vessels* by continuous friction.

I have resorted to baths of 90°, reduced to 80°, with extraordinary success in pneumonia of children and youths, and in adults with temperatures over 103°. The temperature reduction is most marked. I have seen a temperature of 106° reduced to 101° on several occasions, which is impossible under any bath in typhoid fever. The bath is given for from fifteen to twenty minutes in a tub near the bed, as indicated above in typhoid fever, and the patient is rapidly dried. Professor Penzoldt[1] furnishes the following deductions from treating 2200 cases in Erlangen; "If the indication is, besides reducing temperature, to improve the circulation, respiration, and cerebral activity, and to further expectoration, *preference should always be given to a cautious bath treatment.*"

Fismer[2] says that in Basle a reduction of 9.6 per cent. in the mortality of pneumonia has been achieved in 200 cases by the bath treatment.

[1] *Münch. med. Wochensch.*, 1890, No. 36. [2] *Archiv f. klin. Med.*, 1873, p. 445.

In catarrhal pneumonia a more rapid application of colder water—dipping into water at 75°, for instance—would be more effective, as is recommended by Strümpell and others.

In the hyperpyrexia of acute rheumatism Wilson Fox, Medley, Murchison, Sidney Ringer, Charcot, and others have reported reductions of temperature of from five to eight degrees. I reported a case of this kind in the *Transactions of the South Carolina Medical Association* for 1873. Every large joint was enormously swollen; the temperature began to rise rapidly, and had reached 106° when I had the patient gently placed in a tub of cold water and ice applied to the joints. The temperature fell, great relief ensued, and the treatment was continued by means of local cold wet compresses; and after failure of the usual alkaline and other treatment—the salicylates were not then in vogue—hydrotherapy absolutely cured this patient.

The full bath in chronic disease is resorted to by the French and Germans in *piscines*, which are large marble or stone reservoirs with flowing water, which is constantly renewed. They are used as plunges after heat-elevating measures for the purpose of increasing retrograde metamorphosis in scrofula, gout, uric-acid diathesis, polydipsia, and as an *auxiliary* in syphilis. They should not be used on feeble or anæmic persons, in pulmonary or cardiac diseases, nor in affections of the brain and spinal cord.

The Warm Bath.—The uses of this procedure are so different from those of the cold full bath that it demands a separate description.

The technique consists in the simple filling of a tub with water at any temperature near that of the body, say 90° to 106°. The patient lies quietly in it, and obtains the effect of warmth, moisture, and water-pressure. The action of the warm bath upon the body has already been referred to. Its principal uses are soothing or calming to the nervous system, producing sleep and allaying reflex instability when applied for brief periods of time. There is, however, one method of using the warm bath which has been in vogue since Langenbeck devised it in 1855 [1] for the treatment of extensive burns and wounds. The continuous warm bath, called by Hebra the permanent bath, is made by suspending a sheet in the tub as a hammock. The patient lies upon this surrounded by water, which is kept in an equable temperature (warm) by a proper arrangement of in- and out-flow. Hebra used it with great success in large burns, ulcers, and pemphigus. In the latter he retained patients in the bath for several months (except when they desired to defecate), not only without detriment, but with success, the affected parts being protected from the air and kept constantly cleansed and soothed. In more recent literature we find the remarkable results obtained by Riess.[2] From practical application during twelve years in

[1] *Deutsche Klinik*, No. 37. [2] *Berlin. klin. Wochensch.*, 1887, No. 29.

one of the principal Berlin hospitals he derived important results in several hundred cases, comprising paralysis of the lower extremities, paralysis of the bladder and intestines, and in bed-sores, in chronic meningitis, in apoplexy with unilateral contractions, in tetanus, chorea, and sciatica, in dropsies, and in chronic articular and muscular rheumatism. These results would warrant us in applying this bath in any of the above cases when they refused to yield to other treatment.

In *typhoid fever* also Riess reports good results in lowering temperature and diminishing complications. He applies a temperature of 88° F. whenever the body-temperature reaches over 102°, and removes the patient when it is reduced to 100° F. At first the effect is unpleasant, but the patient soon becomes accustomed to this bath. From three to nine hours are required to effect the reduction indicating removal. His clinical charts are very interesting, being examples of one thousand cases. The mortality was 8.5 per cent.; the duration was, singular as it may seem, almost always shortened. All symptoms improved after the first quarter hour, during which time the heart seemed sometimes embarrassed.

This method has a good future. It is certainly less heroic than cold baths, and if properly arranged demands little trouble. When cold baths are objected to, the permanent warm bath offers an excellent substitute.

The Douche.—When water is brought from a height or otherwise issues forth under atmospheric pressure through a tube, in a more or less circumscribed stream, upon localized portions of the body, the application thus made is called a *douche.* This procedure was invented by Pietro Tussignano in 1336. It did not become popular, however, until Priessnitz established his rude mountain-stream douche, which doubtless damaged as many people as it relieved. He gathered a stream of water, falling from a great height, into a wooden gutter about six feet above the head, and allowed it thus to fall upon his patients, who were forced to visit it in all kinds of weather.

The penetrating and inventive genius of Fleury recognized the value of the procedure, and eliminating its disadvantages, constructed it into one of the most useful and powerful nerve-stimuli known to the profession. He systematized its application, and his success in practice brought so many followers that the douche treatment has become a distinctive French method. During a recent European journey I found it almost exclusively used in the numerous hydrotherapeutic establishments in Paris. Duval, Keller, Benis-Barde, and others use it constantly—indeed, almost exclusively. While in Germany the wet pack is the most popular procedure, the douche is not excluded there to the extent that the pack is neglected in France.

The douche is furnished by water delivered under pressure of from

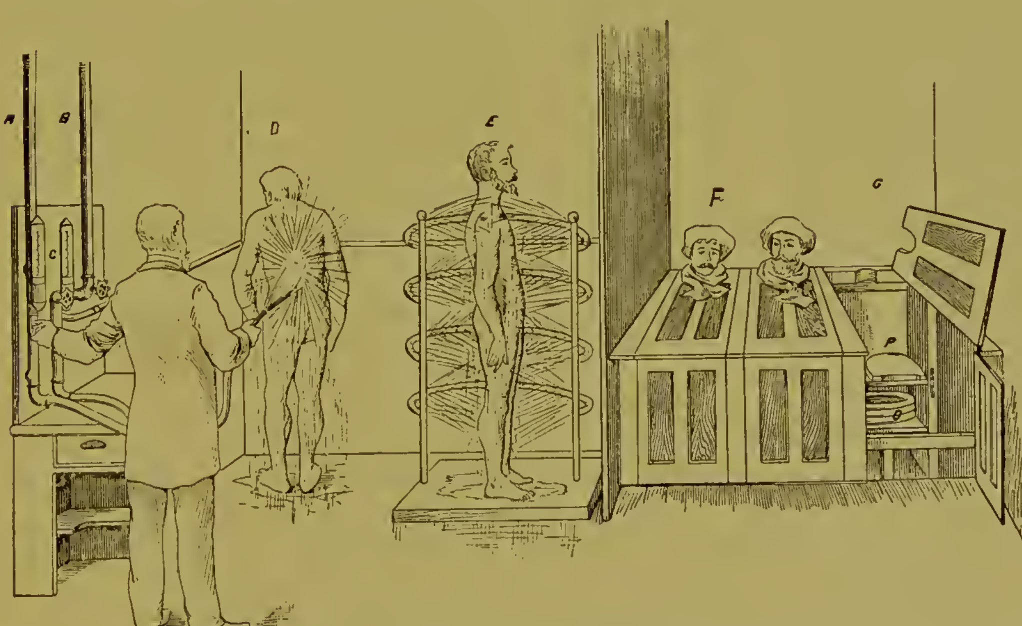
one to three atmospheres, which is equivalent to a fall of from thirty to ninety feet. The most useful arrangement is a fall of about seventy-five feet, with graduated pressures produced by side-outlets or pipes leading from separated reservoirs. It would seem to be more practicable to adapt a compressed-air apparatus to the reservoir, and thus exactly limit the amount of pressure used.

The mode of delivery of the water has furnished certain appellations. The *shower-bath* is one familiar form of the douche. This may be delivered also from a nozzle with numerous perforations which may be attached to a hose, striking the body in a divided stream. Its effect is different from that of the simple douche, called the *jet douche*, which issues from a stationary pipe three feet from the bather or from a nozzle attached to a hose, which is better, and called the *douche mobile*.

The *fan douche* is made by placing a piece of movable copper plate, or simply the finger, over the stream issuing from the nozzle. This spreads the stream like a fan, and when delivered under three or four atmospheres its stings render it difficult to recognize the lowest temperature of the water.

The *rain-bath* consists of from four to six three-fourth circles of pipes secured together at a distance of two to three inches. Each pipe has three lines of fine perforations, from which the stream issues under

FIG. 135.



Author's Douche-room at Montefiore Home.
D, Jet Douche. *E*, Rain-Bath. *F*, Hot-Air Bath. *G*, Hot-Air Bath open, showing *O*, Steam Coil under Seat, *P*.

pressure, striking the body of the patient, standing within it, at all points with considerable force. This is a favorite bath with me at the Montefiore Home as a substitute for the dripping sheet, because large numbers can thus receive treatment rapidly.

Each one of these modifications of the douche requires certain points in the technique which are essential. That *the temperature* of the water must be exact goes without saying. In order to obtain this with precision a thermometer must be secured to the pipes in such a manner that the temperature may be read off before the water is turned upon the patient. The arrangement which is depicted in Fig. 135, which was designed by the writer for the Montefiore Home and has been in use there for several years, explains itself. The pipes are one inch in diameter, nickel-plated, and are connected with the main hot- and cold-water supply. *A* is the hot- and *B* the cold-water pipe. Being connected by *C*, the hot and cold water may be mingled until the requisite degree is indicated on the thermometer, whose bulbs are in contact with the water. As the douche rarely lasts over a few seconds, the change in the temperature of the water during its outflow will not be material.

The *duration of the douche* is a matter of importance. It should always be brief, not exceeding three minutes, usually from ten to seventy-five seconds.

The impression required is evanescent. The douche combines more than any other procedure the pronounced mechanical and thermic elements. Inasmuch as the application is made over various parts of the body successively, it resembles the ablutions or partial baths, but the mechanical effect is more intense. The latter, if combined with a low temperature, produces *hyperæsthesia* of the cutaneous surface, unless it is prolonged beyond one or two seconds, when *anæsthesia* may result. Winternitz found an increase in muscular power, as measured by the dynamometer, and an enhancement of electro-motor excitability, as evinced by the susceptibility to electric influences in paretic muscles only partly obedient to the will. Upon the body-temperature the effect is not pronounced, but upon the blood-pressure, vascular tone, and circulation the effect is the same, only intensified, as other hydriatic procedures.

Therapeutic Indications.—The douche is chiefly applicable in chronic disease demanding a powerful nerve-stimulus. In paræsthesia and paralysis of hysteria, in all conditions of loss of tone in which no organic defect exists in the nerve-centres or their conducting lines, brief douches of water from 60° to 40° are useful. For hysterical convulsions there is one sovereign remedy—cold water, either in a bath or douche, says Strümpell. But as a general tonic the douche is found serviceable in all forms of hysteria in the Montefiore Home.

In anæmia, chlorosis, and other blood-diseases due to disturbed tissue-metamorphosis the douche will prove advantageous for arousing the dormant nutritive energies.

Extraordinary effects are recorded also upon enlargements of the

spleen and liver. Delmas reports actual measurements by Piorry, before and after the douche, applied to the spleen, in evidence of the possibility of moderate reduction of its size by this procedure. In inveterate cases the method should by no means be neglected.

In *chronic inflammatory conditions* on or near the surface the douche may often be resorted to with great advantage, especially in the form of the Scotch douche, which consists of alternate streams of hot and cold water rapidly and briefly applied.

In *chronic rheumatic arthritis* more may be accomplished by this method than by any other local treatment.

In *obstinate neuralgic diseases*, intercostal and trigeminal and articular, the French writers report remarkable results from general douching. Delmas and Duval furnish clinical histories of the most inveterate neuralgias in which, after gradually accustoming the patients to bearing cold water by ablutions, they utilized the douche of one quarter to one minute's duration, of a temperature from 37° to 45° F., promenaded, as they aptly call it, over the entire body, once or twice a day. These histories must be read to be appreciated, that the reader may be imbued with the value of hydrotherapy in these as in other obstinate neuroses.

In this brief *résumé* it must suffice to say that I have had occasion several times to follow the methodical treatment recommended by Duval, with results that border on the marvellous.

In *dyspepsia*, Germain Sée, Ziemssen, and others refer to the importance of douches and other hydrotherapeutic measures. Germain Sée justly claims that, inasmuch as Mosler's vivisected animals showed contraction of the muscular coats of the stomach and intestines, and also diminutions of the spleen, under douches applied to the surface, this method must be useful in atonic states of the muscular and mucous coats of the stomach. Hydrotherapy is called upon to fulfil the most valuable indications in dyspepsia. It stands at the head of the means for combating atrophy of the abdominal muscles, and attacks the root of all troubles of the motor innervation producing dyspepsia. Thermic agents in general, and cold in particular, are powerful modifying agents of motor innervation. After considering the general effects of cold baths, he says it will be necessary to use a cold application of certain duration to the abdomen, made in the intervals of digestion, combined with sedative douches to the vertebral column to diminish morbid excitability of the spinal axis. To stimulate the languishing contractility of the abdominal muscles recourse should be had to rain or fan douches directed on the stomach, or, what is better, to the "Scotch douche."

These douches modify the circulation of the intestinal mucous membrane, the insufficient secretion of the glandular apparatus, the lack of

acidity of gastric juice, and the excessive production of mucus, as well as the general nutrition.

We possess in cold water applied to the skin a powerful means of regulating the action of the heart by augmenting the sum of its useful work.

Peripheral excitation of cutaneous nerves acts reflexly upon the pneumogastric and excites the terminal ends of the splanchnic nerve, causing contraction of the vessels controlled by these nerves. Thus a more active and healthful circulation is produced in the chylopoietic viscera.

For *obesity* we possess in cold douches, properly applied in connection with vapor-baths, as shown by Godlewsky and Anton Frey, a most powerful agent for producing metamorphosis of fatty tissue. The ordinary method of gradually lowering the temperature of the douche, adopted in Turkish and Russian bath establishments, defeats the physiological action above referred to as resulting from intense thermic impressions, and are therefore as absurd as many other hydriatic procedures practised by uneducated people. Unfortunately, physicians do not attach sufficient importance to the absurdity of these Turkish-bath practices, which delude corpulent people into a belief that they are benefited because the scales show a reduction after the bath.

Improved tissue-metabolism, especially the consumption of more nitrogenous tissue-material, results from *pronounced* thermic impressions alone. Hence the douche following the vapor-bath, if it is applied for the purpose of fat-reduction, should be in decided contrast with the temperature of the skin. A temperature not above 70° should be tried the first time for one minute. This should entirely cease for five minutes, to allow the patient to react. Now a douche of 60° may be tried if the pressure is over one atmosphere. Five minutes should again elapse ere the third douche is given, and this should only be given to vigorous people. If full reaction has occurred, the last douche may be given at 50°, or even 40° F. No harm will ensue from the latter temperature if the stream comes in a spray under great pressure, say three atmospheres (ninety feet descent). Having thus ascertained the patient's reactive capacity, a lower temperature may be begun with each vapor-bath. The reported results are very satisfactory. But this treatment should never be undertaken by the lay attendant without medical supervision and cautious adaptation. The highest and lowest contrasting temperatures which the patient is capable of bearing without detriment are the most efficacious in removing an excess of fat. This is a principle established by physiological experiment and corroborated by clinical experience.

To sum up; the *douche* is adapted to the most varied conditions and is capable of fulfilling every function of a hydrotherapeutic procedure. According to its temperature, form, duration, and atmospheric pressure,

we may abstract heat, produce contraction and dilatation of blood-vessels, slow the action of the heart and improve its force, deepen the respiration, send the blood to parts formerly sluggishly vascularized, and draw it from hyperæmic portions, excite nerve-influence of various degrees, produce change in functions, secretion, and tissue-changes. Our French confrères regard the *douche mobile* as the therapeutic arm of the physician, and place it at the head of all other procedures.

The Sitz Bath.—These baths are administered in tubs arranged for this purpose, and made of wood or zinc, so that the patient may sit comfortably in them, while the feet repose outside upon a raised surface and blanket, so that the popliteal spaces are not encroached upon by the edge of the tub. The water should reach the umbilicus. The cold sitz bath (60° to 75° F.) has been frequently the subject of investigation. Heat is abstracted, the respiration is deepened and slowed, and the heart acts more forcibly and slowly under its influence. Weisflug[1] observed a slight rise of temperature from cold sitz baths in the normal conditions, while in fevers no diminution could be noticed. After the bath the pulse became softer and slower and the temperature fell. In fevers each bath was *succeeded* by an increased fall of temperature.

The first effect of a cold sitz bath is a feeling of oppression in the head, sometimes resulting in vertigo; the cerebral and facial vessels are congested; there is dyspnœa, followed by a deeper respiration. The volume of the other parts of the body is increased, as Winternitz has shown with his pletysmograph on the arm. The blood thus brought to the surface must come from the viscera, to which, if the bath is brief, it returns at once; if prolonged, there results a veritable diminution of blood in the abdominal organs. This has been demonstrated by Winternitz, who has also pointed out the fact that the intra-abdominal vessels form a reservoir which receives and gives off blood, perhaps to an even greater extent than the cutaneous vessels. Their capacity for change is a safety-valve for regulating the blood-pressure of the entire body.

Golz's "tapping experiment" demonstrates how the mesenteric vessels of a frog were filled when the blood was driven from the surface. The phenomena produced when the lower part of the human body is placed in a tub of cold water can only be explained by the devascularization of the internal vessels, chiefly those of the abdomen and pelvis.

A reflex excitation of the sympathetic plexus is probably the chief agency in this effect upon the blood-vessels. The axillary temperature is also raised during the first portion of a sitz bath, due to the increased flow of blood to the upper part of the body.

Therapeutic Indications.—The narrowing of the intra-abdominal

[1] *Archiv f. klin. Med.*, 1886.

vessels would naturally produce change of function in the organs supplied by them. Hence we have here an excellent method of treating the most obstinate cases of diarrhœa, in sitz baths of 54° to 60° of half an hour's to one hour's duration, or longer with care, preceded by a good wet sheet rubbing to dilate the cutaneous vessels and thus aid the derivative effect. In menorrhagia, subinvolution of the uterus, and pelvic cellulitis these baths are exceedingly useful, inasmuch as they reduce local temperature, diminish hyperæmia, increase the tone of the muscular fibre and that of the coats of the pelvic vessels, and enhance local tissue-changes.

In obstinate amenorrhœa dependent upon local anæmia, as is mostly the case, brief sitz baths of from 40° to 50° for eight or ten minutes, with friction, and repeated twice a day, are useful as driving blood to the pelvic vessels, and by reaction withdrawing it again to the surface.

In a depressed condition of the sexual function of the male the same treatment is useful. Care, however, should be exercised in seminal emissions to ascertain the cause, if possible, since many cases of hyperæsthesia would be aggravated by these cold baths, while warm or more temperate baths would be useful. Warm sitz baths are useful as agents to diminish the activity of the cerebral circulation.

In acute and subacute amenorrhœa, cystitis, intestinal and vesical tenesmus, prolonged baths of from 90° to 100° are valuable remedies. In chronic metritis, subinvolution, and all troubles accompanied by bearing-down and lumbar pains a graduated sitz bath has been with me among my most useful procedures for twenty-five years. It is best taken before retiring. The patient seats herself in a hip-tub containing water at 95°, to which she adds slowly (without touching the body) cold water (less than 50°) until she feels chilly. Upon rising she dries the skin and practises thorough friction. Many other uses of the hot and cold sitz baths will suggest themselves to the practitioner who understands their *rationale.*

The Use of Water in Cavities of the Body.

This is a special branch of hydrotherapy which has been developed within the last two decades into an important one.

Stomach Irrigation.—To Leube and Kussmaul we are indebted for the popularization of stomach irrigation, which for diagnostic and therapeutic purposes I have found of immense value. The technique consists of introducing one-third of a soft but firm rubber tube, sixty inches long and of a diameter of half an inch, into the stomach, pouring warm water through a funnel connected with the tube into the stomach, and allowing it to run out by siphonage into a vessel. The end of the tube being held between the thumb and forefinger, it is pushed into the pharynx through the open mouth, while the patient is asked

to swallow. Gagging results, but gentleness and calm persuasion overcome the patient's fear of choking. About a pint of water is poured in at once to avoid over-distension. It is well to protect the patient's clothing by a rubber or oilcloth sheet.

For diagnostic purposes about one and a half to two quarts of warm water, poured in five hours after a full meal, suffice. The water emitted will show what portions of the food are not digested, how much if any mucus is present, and the muscular power of the gastric walls will be tested by the readiness with which the stomach expels the water.

For therapeutic purposes the chief value of these irrigations is found in gastric catarrh with enfeebled muscular walls, which permit over-distension and lessen the motor-power of the stomach.

In some cases of hepatic colic from gall-stone, and even in cases of ileus, Rosenthal, Kussmaul, Senator, and others have applied stomach irrigation with so much success that this measure should always be tried before resorting to surgical means.

In the gastro-intestinal disturbances of infants Ebstein and Leo in Germany and Seibert in this country have obtained excellent results from stomach irrigation, which I can endorse from personal observation. It will remove all fermented and fermenting material from the stomach, and give a clean beginning, which aids in the digestion of sterilized milk.

Intestinal irrigation is another hydriatic procedure that is now commonly resorted to with great benefit.

In catarrhal jaundice Krull has shown us how to cure cases rapidly by daily irrigating the bowels with water of from 60° to 75°, and I can testify to its value from personal experience. The effect is explicable upon the experiments of Bidder and Schmidt, Lehman, Roehrig, and others, who have clearly proved that the introduction of large quantities of water into the stomach and intestines produces a more decided increase of bile than the entrance of water into the blood.

In acute and subacute dysentery the removal of irritating matters and pathological products, added to the soothing effect of the warm water, will do more to allay tenesmus and cure the disease than all other remedies combined.

In the obstinate intestinal catarrhs of infants and in acute summer diarrhœa I rely upon intestinal irrigation with warm alkaline water to bring relief in the most unpromising cases. Indeed, I view these alarming cases with indifference, since abstinence from milk food, and its sterilization later, together with stomach and intestinal irrigation and cool baths and compresses, have become my chief reliance.

The *hot vaginal* douche need only be referred to here as a hydriatic procedure of well-recognized therapeutic value. It should be applied with careful attention to the details established by its originator, Dr. T.

A. Emmet, who, if he had made no other contribution to gynecology than this, has earned the lasting gratitude of suffering women. The flat douche-pan devised by Dr. H. T. Hanks, and the use of the Davidson or "alpha" syringe with large quantities of water at 110°, constitute the important technical trio.

In post-partum hæmorrhages there is no remedy equal to hot irrigation of the uterus, with proper provision for outflow from the cervix.

Surgical Asepsis, it may be claimed with justice, owes more to hydrotherapy than to all else for its efficiency. The irrigation of operative fields and wounds with warm water is far more valuable than antiseptics, as the profession is slowly beginning to appreciate.

Water-Drinking.

This is a therapeutic auxiliary which is too highly lauded and carried to an extreme by the hydropaths, and yet is too much neglected by the profession.

The drinking of hot water before meals has become quite a routine practice now. Here, again, precision is demanded to prevent failure. The water should be as hot as it can be borne, and drank at least an hour before each meal.

Drinking large quantities of water of different temperatures produces definite effects. Water of 60° or less in moderately large quantity reduces, according to Lehman, the pulse for about eleven minutes, and the rectal temperature falls.

The absorption of water from the gastric vessels depends upon their tension, being most rapid when the latter is low.

The idea that the imbibition of large quantities of water renders the blood more watery is erroneous. Boecker has clearly shown that this is a very transient result, and that in half an hour the blood is really less watery than it was after twenty-four hours' abstention from water. It acts as a diuretic, not alone increasing the watery parts of the urine, but also the solids, especially the urea and the phosphates and sulphates. This would indicate an enhancement of retrograde metamorphosis of nitrogenous material. This is also confirmed by an increased carbonic-acid excretion and oxygen absorption when large quantities of cold water are consumed.

An interesting observation by Mosler is to be remembered as of practical value. He has found that the consumption of large quantities of water produces more decided effects upon women and children than upon male adults. Drinking large quantities of cold water increases peristaltic action, as evidenced by the expulsion of gases. The quantity of uric acid is also said to be decreased when water is drunk, and other secretions, as that of the parotid gland, are increased. Diaphoresis is certainly increased by copious water imbibition.

It follows, therefore, that the *therapeutic indications* for drinking water are found in all those diseases in which a rapid interchange of tissue-materials is desired, or in which elimination of pathological material is to be facilitated, or in which diaphoresis or diuresis is to be stimulated. Too little use is made of this important physiological modifier by the general practitioner.

Hot-air and Vapor-baths.

As auxiliary measures to hydrotherapy the so-called Turkish and Russian baths are often used.

The French constantly apply the hot-air baths by means of a box in which the patient is surrounded by hot air (furnished by a lamp), while his head is outside, as a preparatory measure for their douches. This is far superior for remedial purposes to the usual Turkish baths, in which the patient is compelled to inhale hot air, often rendered noxious by the enforced restriction of ventilation. At the Montefiore Home the boxes shown in Fig. 135, *F*, *G*, are supplied by a steam coil, which elevates the temperature of the air to 130°, and 150° if necessary. Very high temperatures are really not needed. My method is to be guided by the effect upon the patient's temperature, which may readily be taken in the mouth, and by his pulse. If the former is raised from one-half to one degree, and the skin is in active perspiration, and if the pulse is accelerated to over 120, the patient is removed and subjected to such hydriatic procedures as are indicated in the case.

The usual method of gradually reducing the temperature of the water is doubtless pleasant, and perhaps useful in health, but in disease it neutralizes the reflex effect upon the peripheral nerves, as has been mentioned above.

The vapor or Russian bath may be produced also in the box bath by permitting steam from a pipe to permeate it, and providing for its escape.

The ordinary baths of this kind supplied in establishments are so familiar that it is unnecessary to describe them, as they abound in all places where they are used, and their modification by boxes or cloaks enables the practitioner to imitate them successfully even in the remotest rural districts.

The rationale of these baths has been dwelt upon already. They raise the temperature, increase the pulse and respiration, and enhance tissue-metamorphosis. They are therefore invaluable in rheumatic and gouty affections and in some cases of chronic nephritis and in obesity. In the latter the hot vapor-bath, followed by cold douches, is to-day the most useful auxiliary to diet and muscular exercise.

Sand- and Mud-baths.

The first of those is prepared by surrounding the body in a tub with a layer of dry warm sand which has been naturally or artificially heated. The temperatures usually applied are from 95° to 120°, and their duration one to one and a half hours. The head is wrapped in a wet towel and permitted to lie outside of the sand. After removal from the sand-bath the body is treated as after a hot-air bath. By this means the pulse and respiration are accelerated as in other warm baths, and profuse perspiration ensues.

The mud-bath is prepared by mixing well-seasoned earths, containing more or less mineral matter, with water containing the same substances, and surrounding the body with this mixture at various temperatures from 90° to 100°. After the mud-bath the patient is rinsed with warm water, and as a large quantity is required to cleanse him of the filthy mass, he really obtains a prolonged bath in addition.

Kisch claims he has ascertained sphygmographically that these baths elevate the tension of the vascular system more than the ordinary warm bath, and as they may be given at a much higher temperature, their effects are more decided.

The therapeutic indications for the use of sand- and mud-baths are various, and they may be given either partially or completely. They act as emollient or heat-enhancing procedures, according to their temperature.

In uterine diseases of indefinite character, not amenable to surgical treatment, mud-baths may be of value. It is difficult to understand how any mineral admixture can be expected to be useful, since it is a well-established fact that they are never absorbed through the uninjured skin. Still, they have been found very useful in obstinate rheumatism and gout, and in Franzesbad for uterine disease. It is claimed by Kisch that the iron mud-baths cure enlargement of the spleen. How much the psychical element and subsequent douching contribute to the cure is still undecided. There is certainly sufficient demonstrated value in these baths to entitle them to a fair trial.

General Conclusions.

An unbiassed review of the physiological observations of the action of water explains at once the seeming paradoxical effects of hydriatic procedures upon the human body, and offers a rational warrant for the remarkable historic fact that amid all the vicissitudes of therapeutics water is the only remedy which has successfully resisted the prejudices of medical men and of the laity.

Hydrotherapy has maintained its position, not only on empirical grounds, but it is to-day more firmly entrenched in the minds of

progressive medical men than it ever was before, simply because *it is based upon well-ascertained and exact physiological facts*, the application of which forms the most brilliant chapters of clinical medicine.

It is, however, far from the writer's intent to enter into a propaganda for hydrotherapy as an exclusive treatment of disease, and thus rank himself with those empiries, the hydropaths, who have done much to discredit the remedial value of water. He would stultify his entire record were he to announce his adhesion to so absurd a doctrine.

Aside from the valuable medicinal acquisitions of the past, modern research has given and is still giving us remedies whose exact and positive effects upon the system are startling, and must, when they are fully appreciated after the enthusiasm of novelty passes away, enrich our therapeutic armamentarium vastly. It does not detract from these to bring forward a plea for this ancient and well-tried friend of the physician, whose triumphs at the bedside have been recorded by some of the best and ablest exponents of medical science. I plead for a fair and impartial test of water as a therapeutic resource, based upon its historical record, its physiological rationale, and its clinical results.

Whosoever shall read the history of this therapeutic agent from the time of Hippocrates, and pass in review some of the men who from time to time warmly espoused its many-sided advantages, must conclude that its claim on this score commands our highest respect. Since the day of Priessnitz (who built up a stupendous empirical structure upon water as a sole remedy), however, medical men have stood aloof and permitted his followers to monopolize the valuable properties of this agent. Its revival was brought about by French physicians, who at that time did not look askance at German medicine, but even went to the extreme of studying German empiricism. The celebrated French physician Scoutetten, who had been sent by Marshal Soult to Graefenberg, brought back a favorable report, which stimulated the adoption of hydrotherapy by French physicians, among whom it is at the present time much in vogue in acute and chronic diseases, chiefly in the treatment of the latter, as taught by Charcot and Dujardin-Beaumetz. It was not until 1861 that the Germans were again aroused to a realization of the remedial value of water by Ernst Brand. Niemeyer, Bartels, Juergensen, Hoffman of Leipzig, Vogl of Munich, Nothnagel, Fuerbringer, Erb in Germany, Semmola and Cantani in Italy, are names familiar to students of modern medicine which stand as vouchers for the good repute of hydrotherapy in recent times. One man stands above all others—Wilhelm Winternitz, to whom we owe nearly all we know of modern scientific hydrotherapy. In this essay his work has been so often utilized that it would be tiresome iteration to quote him again.

It is my aim to stimulate a revival of hydrotherapy, as far as lies in my power, by a plain, unvarnished exposition of its methods and results from the most reliable sources, but not to encourage its application as a sole remedy to supplant all approved medicinal or other agents.

To sum up the aims, capabilities, and results of hydrotherapy, it may be said—

1st. We possess in this method a valuable auxiliary to methodical treatment of many, though not all, acute and chronic maladies.

2d. In acute diseases its value is most demonstrable in the *early* stages of pyrexia, in which it will accomplish more than any other remedies; it may also be usefully applied in non-infectious diseases of short duration.

3d. In many chronic diseases it has proved so successful after failure of medicinal remedies that *no case should be yielded up as hopeless until hydrotherapy in some form has been tried.* My experience at the Montefiore Home, which receives only incurable cases, demonstrates this fact.

4th. Domestic treatment by the methods here indicated will suffice in most cases, but if these fail a methodical treatment under an expert hydrotherapeutist may be to the advantage of the patient.

The most important elements are the thorough mastering of the general principles of hydrotherapy, precision in their application, and their perfect adaption to the constitutional peculiarities of each case—*i. e. not treating the disease, but the patient.* For this reason the best consultants in Germany, in Italy, and in France—men like Leyden, Charcot, Senator, Semmola, Ziemssen, Krafft-Ebing, Bernhardt, Mendel, Nothnagel, Binswanger, Erb, and Leube—send their patients to hydrotherapeutic establishments which are under the direction of educated physicians who have studied the subject, with their diagnosis and general suggestions, rather than with specific directions for the method to be employed.

Finally, so much depends upon the reactive capacity of each patient that only systematic observations can determine the most useful hydriatic procedure in each case.

MINERAL SPRINGS.

Balneology concerns itself with the study of the chemical, thermic, and other properties of waters issuing from the earth, and Balneotherapy deduces therapeutic results from this study.

Although an immense literature has accumulated concerning this

subject, the precision which modern medicine demands is still lacking. Unfortunately, the accuracy of the empirical results of balneotherapy are woefully marred by the bias due to one-sided study and observation of men who, be they ever so honest, must be misled by their environment and their constant advocacy of certain waters with which their personal interests are intimately interwoven. Thus, we are confronted in this question with far greater difficulties than in the discussion of ordinary therapeutic questions. In the latter we are able to obtain observations from various sources—from men living in different countries and unbiassed by local pride or interest; we are able to classify the results as recorded in polyclinics and hospitals as well as in private practice. Moreover, the observations are usually made upon one single pharmaceutical product. In the matter of mineral waters, on the contrary, we have many other elements to consider. The observations of each water can be made only at the springs from which it issues, with few exceptions; there are a large number of ingredients in each water, rendering it impossible to ascribe therapeutic effects to one or more in particular, although this is constantly attempted; there are other elements, such as the general effect of bathing or drinking, the climate, the surroundings, etc., to be considered. These considerations furnish a reason for the scepticism which the logical and unbiassed observer must entertain toward the effects of baths and mineral springs outside of their hydrotherapeutic influence. A few facts seem to me to be deducible from a careful survey of the subject.

In the first place, it must be conceded that since no precise observations in sufficiently large numbers are available for the physiological study of baths and mineral waters, we must be guided entirely by the practical results based upon empirical observations.

That visits to mineral springs are of immense value in the treatment of disease no one can be more ready to grant than the writer, for it is a matter of daily observation that patients afflicted with all kinds of curable and incurable maladies journey to these resorts and return from them either cured or greatly improved. To analyze the rationale of these positive effects is an undertaking which the writer would have preferred to leave to others. The following propositions seem to him quite plain, however:

1st. The effects of bathing in mineral waters differ very slightly, if at all, from those of bathing in ordinary water.

Although there are a few (very few) observations claiming, like those of Heidenhain and Roehrig and Zuntz, that baths containing salts or gases have a stimulating effect upon the skin of animals, these experiments have, as Leichtenstern has clearly shown, no significance. Moreover, they have not been authentically demonstrated on man, who is so frequently under observation that it would not be difficult to

obtain them if they could be made positive. Suffice it to say, that Liebermeister and Rembold's experiments with cold salt baths, and Leichtenstern's with warm salt baths, show no difference in temperature effect from plain water baths.

The fallacy of experiments on the effect of mineral-water baths cannot be better exposed than to cite one usually much quoted. Flechsig, who took the greatest care to ascertain the effect of lukewarm iron baths compared with those of plain baths, analyzed all the food he took and all the excreta, but was unable to investigate gaseous baths and ingesta because his apparatus was imperfect. Although he made these investigations alternately while using the different baths, he paid no attention to the kind of food, which he took as his appetite prompted. I agree with Leichtenstern in regarding this inexactness as an evidence of unreliability of the experiments, even though made by one of the best-informed and unbiassed of balneologists.

In brief, there is no evidence to prove that baths of chloride of sodium, for instance, have a specific power on absorption processes; that baths containing iron increase the hæmoglobin, or that there is any specific action in sulphur baths in eliminating metallic or rheumatic poisons, as is so constantly claimed. That absorption of water may occur in the surface layer of the skin cannot be doubted, but its penetration beyond the inner layer has never been proved. The fact is, the water absorbed is again evaporated: Roehrig proved on his own person that after a salt bath of an hour for five days there was no increase of chloride of sodium in the urine over that of the previous five days. On the other hand, Neubauer and others claim an increase of chloride of sodium from such baths, which, however, is so small that it may be accounted for by the ordinary variations. The best evidence that mineral constituents of baths are not absorbed into the system is furnished by numerous experiments by Lehman and others with ferrocyanide-of-potassium baths, of which not a trace could be found in the urine, and of lithia baths, whose presence in the urine even spectral analysis could not demonstrate. *Indeed, all agents* (as arsenic, copper, morphine, antimony, belladonna, etc.) *dissolved in water that were not, like iodine, sulphur, etc., volatile, failed to appear in the urine.*

The fact that the skin is capable of absorbing matters contained in a finely diluted spray, or metals like mercury and iodine when well rubbed in and volatilized, or gases like chloroform, carbonic oxide in concentrated form—all of which it has been demonstrated are absorbed—does not prove aught in favor of absorption from water. It has been amply demonstrated that the oleaginous nature of the sebaceous secretions utterly bars out aqueous absorption, but that this may be overcome by friction and neutralization with alkaline soap, which, however, very rarely play any part in the usual mineral-water baths.

It may be safely concluded, without depreciating the value of the other elements concerned in the resort to mineral-water baths, that aside from their volatile ingredients their effect is not due to their mineral constituents.

It should by no means be inferred that the writer is averse to their use, for the psychical effect is far more valuable than any chemical effect would be if available. All the effects, too, of ordinary bathing are enhanced in these mineral baths, because the environment of the patients, the influence derived from fellow-patients—some of whom are always found ready to laud the baths—etc. render this mode of bathing far more agreeable than the hydrotherapeutic procedures described in the first part of this article.[1]

Drinking of Mineral Waters.—Here, again, several elements are operative:

1. The exhilaration due to the improved hygienic, atmospheric, and scenic conditions under which the patient is placed;
2. The freedom from care and absence from business pressure, together with the stimulus of amusements and diversion;
3. The regularity of habit inculcated, together with the strict diet and regimen;
4. The drinking of unwonted large quantities of fluid, which sweeps out effete material;
5. The mineral ingredients.

The latter two chiefly concern us here.

In drinking water the effect depends upon the temperature and quantity imbibed. Cold water taken on an empty stomach produces contraction of the muscular coats of the stomach and its vessels, a reduction of the body temperature, and also some effect on the intestinal muscular coats.

Warm water, on the contrary, exerts its chief effect as a cleansing agent of the mucous membrane of the stomach and as a stimulant to its secretions. Hot water exercises a beneficial influence as an anti-fermenting and cleansing agent.

The imbibition of much water produces a certain over-saturation of many tissues, and decided fluctuations in the excretion of urea result, without, however, materially affecting the average production.

Many of the glands, as the parotid, pancreas, and liver, feel such an active impulse as a result that water-drinking has been successfully applied as a stimulant to their functional activity.

It is well known that water containing salts is more rapidly

[1] American springs would be far more popular were the method of using them less irrational. If physicians at these resorts would insist upon precision in drinking and upon attention to diet, hydrotherapy proper, and exercise, facilitating these auxiliaries, as is done in Europe, the annual exodus from this country would be greatly diminished.

absorbed through the veins and lymphatics when taken upon an empty stomach, and that the rapidity of its absorption depends upon the concentration of the salt, because a 2 per cent. solution of salts would render osmosis difficult or impossible.

The heart is stimulated to increased action by excessive water-drinking. That the blood is rendered markedly dilute by drinking large quantities of water is not proved; indeed, this is denied by so good a physiologist as Magendie and by many others.

A decided effect upon tissue-changes results, however, especially if large quantities of warm water are taken.

The effects of free drinking of water, therefore, may be summed up in the saturating of the tissues, the increase of vascular tension and capillary pressure, and the solvent action upon various pathological and chemical elements residing in the body. The therapeutic results may be logically deduced from these.

Phoebus has with great labor calculated the quantity of each constituent of mineral water which must be consumed in twenty-four hours in order to obtain in ordinary conditions the therapeutic effects expected. He calls his deductions, made from observations of himself and others during ten years of the actual remedial effects of these ingredients, pharmaco-dynamic equivalents. Taking five goblets, or one litre, as an average daily quantity, he places these values—therapeutic equivalents—for each ingredient per litre per day as follows:

Carbonic acid	3 grammes.
Simple carbonate of sodium	1 gramme.
" " lime	1.50 grammes.
" " magnesium	1.50 "
Chloride of sodium	3 "
Sulphate of sodium	1.50 "
" magnesium	1.50 "
Chloride of calcium	0.60 gramme.
" magnesium	0.90 "
Iodine (in all combinations)	0.35 "

In waters of which a litre is not consumed per day the value—therapeutic equivalent of the chief ingredient, *e. g.* the sulphates in the bitter waters—is very high. We find here, approximately, the contents of each goblet by dividing the therapeutic equivalent by five (Kisch).

Uses and Classification of Mineral Waters.

A large number of classifications have been proposed in this country and in Europe. Some of them are based upon the therapeutic action of the waters, while others have been made with the view of indicating their chemical constitution. After a careful study of the

various classifications adopted here and in Europe, it seems to be most conducive to a proper understanding of the subject to employ a somewhat different system, which, while not free from imperfections, has, at any rate, the merit of simplicity.

Inasmuch as the therapeutic action of any given mineral water is supposed to depend upon the character and quantity of its chief chemical ingredients and upon the temperature of the water, any classification which embodies these points must approximate most nearly to a perfect system. Owing to the fact that some of the waters contain large quantities of various chemical constituents having different therapeutic properties, it becomes necessary to refer to them under several headings. Only the mineral waters of America and Europe which have been analyzed by competent chemists, and the merits of which have been generally recognized by the medical profession, will be mentioned here. A large number of springs in various parts of this country, which, although comparatively unknown, possess positive medicinal virtues, have been omitted, the aim being to furnish the practitioner with a number of characteristic examples of each class, depending upon his individual discrimination to select waters, approximating these in chemical composition in cases where their use is indicated. It will also be shown that this country boasts of mineral springs rivalling, if not surpassing, in virtues the most celebrated ones in Europe, and that if more attention was paid to the hygienic and social conditions at our health-resorts, and to the development of their scenic beauties, the results obtained would be fully equal to those observed on the continent of Europe.

Mineral waters may be divided into—1, alkaline; 2, saline; 3, sulphuretted; 4, chalybeate; 5, acidulous; 6, waters characterized by special ingredients (alum, sulphuric acid, borax, iodides, bromides, etc.); 7, calcareous; 8, thermal. In estimating the value of any of these waters due consideration should be given to the mere effect on the system of drinking large quantities of water—an effect which probably exceeds in therapeutic value that produced by the mineral ingredients, which are frequently present in minimal quantities.

Alkaline Waters.

The chief ingredients of these waters are the alkaline carbonates, especially the carbonate of sodium. They also contain varying amounts of the carbonates of lime, magnesium, and lithium, sodium chloride, etc., and many of them are strongly charged with carbonic acid gas. Although it is probable that the other saline constituents may contribute to the total physiological effect of these waters, they owe their main therapeutic activity to the alkaline salts they contain. The temperature of these springs is also a point worthy of consideration, as has

been mentioned above. In the section on thermal waters we will discuss these effects *in extenso*.

In a general way, it may be said that the physiological action of these waters is like that of any alkaline salt, plus the effect produced by the circulation of large quantities of water in the system. The carbonate of sodium neutralizes free acids or fermentation-products in the stomach whether taken during or after meals. According to Brunton and Sidney Ringer, the stronger alkaline waters, if taken before meals, increase the secretion of gastric juice. The carbonic acid set free by the decomposition of the carbonates in the stomach, and the sodium chloride usually present in these waters, act as a stimulant to the gastric mucous membrane, promoting secretion and counteracting any disturbing influence exerted by the carbonate. The free carbonic acid frequently contained in waters of this class by its stimulating effects on gastric peristalsis accelerates digestion and thereby increases the desire for food.

Absorbed into the blood, the carbonate of sodium in the water augments its alkalinity, and thus promotes oxidation processes and tissue-metabolism. Under its use the urine becomes alkaline, the quantity of urea is greatly increased, while that of uric acid is correspondingly diminished. The function of the mucous membranes throughout the body is stimulated, and thus, according to Flechsig, these waters become anticatarrhal remedies of a high order. It has been generally supposed that the alkalies increase the oxidation of fats and sugars, and to this effect has been attributed the curative action of such waters as Marienbad and Carlsbad in diabetes; but this theory has been controverted by Leichtenstern.

It would appear, therefore, that the alkaline waters have a wide range of usefulness. They seem to be especially indicated in gastric affections in which there is an excessive production of hydrochloric acid, as in acid dyspepsia, atony of the gastric mucous membrane, and gastric ulcer. In all catarrhal conditions of the stomach they are most serviceable, but a free and prolonged use lowers the nutrition, except in the case of those waters containing chloride of sodium. Catarrhal inflammations of the mucous membranes of the respiratory tract are frequently benefited by a course of alkaline waters, owing to their action in augmenting and liquefying the mucous secretions. They have proved themselves excellent expectorants in acute and chronic laryngitis and bronchitis, especially the thermal members of this group. It is, however, especially in catarrhal conditions of the bladder that they enjoy a high reputation for efficacy. They neutralize the acid of the urine, and thus rid it of its irritating effect upon the vesical mucous membrane; and, aside from this, they probably exert a direct anti-catarrhal action.

In the uric-acid diathesis and in lithæmia they promote the oxidation of excretory matter and dissolve uric-acid deposits; and for this reason those containing sulphate of sodium especially, which stimulates the portal circulation, have been highly recommended in gout and rheumatic affections, hepatic hyperæmia, and obesity. In all these conditions, as already stated, the effect of the alkali is supplemented by the large quantities of water imbibed, which flush the emunctories and dissolve and drain away the products of tissue-metabolism. The experiments of Lewaschew have shown that the carbonate of sodium promotes the biliary secretion; and this effect may be utilized in the treatment of diseases of the gall-bladder and bile-ducts.

The following table presents a small number of characteristic alkaline springs of America and Europe, arranged in such manner as to enable the practitioner to draw a comparison between *celebrated* waters of this class in Europe and those in this country resembling them in composition. For the purpose of simplicity the quantities of active ingredients are given in round numbers, and no attempt has been made to mention all the constituents, since some of them are present in such extremely small amounts that they cannot be regarded as contributing to the medicinal properties of the waters:

Illustrative Comparative Chart of Alkaline Waters.

American.	European.	One pint contains—			
		Sodium Carbonate.	Carbonic Acid Gas.	Temperature.	Other Important Constituents.
		grs.	cub. in.	Fahr.	
	Vichy (Grande Grille Spring), France.	26	14	105.8°	Sodium chloride, 4; sodium sulphate, 2; potassium carbonate, 2 grains.
Ojo Caliente Spring, California.	. . . .	14	. . .	100°	Sodium chloride, 4; sodium sulphate, 1 grain.
	Fachingen Spring, Germany.	19	32	50°	Sodium chloride, 4; calcium carbonate, 2 grains.
Saratoga Vichy Sp'g, New York.	. . . .	11	48	50°	Calcium and magnesium carbonates, 17; sodium and potassium chlorides, 18 grs.
	Ems (Kesselbrunnen Spring), Germany.	10	6	115°	Sodium chloride, 7; calcium carbonate, 1 grain.
St. Louis Spring, Michigan.	. . . .	7	1	50°	Calcium and magnesium carbonates, 6; calcium sulphate, 7 grains.

It will be seen from the foregoing table that the European waters of this class are somewhat richer in alkaline salts than the American. Besides those already mentioned, a large number of alkaline waters occur in Europe and this country, from which the following have been selected as examples:

Europe: Mont Doré, Royat, and Vals in France; Apollinarisbrunnen, Geilnau, Obersalzbrunn, Selters, and Weilbach in Germany;

Bilin, Giesshübel, Franzensbad, Karlsbad, Marienbad in Bohemia; Gleichenberg (Johannisquelle), Rohitsch in Styria; and Luhatschowitz in Moravia, Austria; Passug and Tarasp in Switzerland.

America (*United States*), *Alabama:* Bladon Springs, Choctaw Co.—*California:* California Seltzer Springs, Mendocino Co.; Congress Springs, Santa Clara Co.; Napa Soda Springs, Napa Co.; Vichy Springs, Santa Clara Co.—*Colorado:* Manitou Spring, El Paso Co.—*Illinois:* Perry Springs, Pike Co.; Versailles Springs, Brown Co.—*Oregon:* Lower Soda Spring, Linn Co.—*Vermont:* Sheldon Springs, Franklin Co.; Middletown Springs, Rutland Co.; Welden Spring, Franklin Co.—*Virginia:* Jordan Alum Springs, Rockbridge Co.; Orkney Springs, Shenandoah Co.—*West Virginia:* Capon Springs, Hampshire Co.—*Wisconsin:* Bethesda Springs, Waukesha Co.

Saline Waters.

This class may be conveniently subdivided into, first, waters containing chiefly the chloride of sodium; and second, waters containing large quantities of the sulphates of sodium and magnesium, the so-called bitter waters of German authors.

The Sodium-Chloride Waters.—These waters contain, besides large quantities of sodium chloride, a certain proportion of other chlorides, especially those of lime and magnesium, and small amounts of alkaline and earthy sulphates and carbonates, iodides and bromides. Carbonate of iron is sometimes present in considerable quantity. The gases consist for the most part of carbonic acid, which renders the water more agreeable to the palate and more readily absorbed, while some of these waters are heavily charged with sulphuretted hydrogen. They occur both as cold and thermal springs, and may be utilized for both drinking and bathing purposes.

The physiological action of these waters is chiefly attributable to the presence of sodium chloride. This salt, as is well known, has a stimulating effect upon all the mucous membranes of the body, especially that of the gastro-intestinal tract. In the stomach it dissolves the mucus, increases the secretion of gastric juice, promotes the digestion of albuminous substances, and excites peristalsis. In the intestines it stimulates the flow of pancreatic juice and bile, and owing to its well-known influence on the process of osmosis promotes the absorption of food. Intestinal peristalsis is also increased, and if the sodium chloride is present in large quantity the water may be laxative, and even purgative, in its effects. Some authors have regarded this purgative action as representing the chief therapeutic virtues of these waters, but, according to Flechsig, it is subordinate in importance to the effect of the sodium chloride on the blood. He states that this salt exerts considerable influence on the process of tissue-metabolism, augmenting the

metamorphosis of nitrogenous matters and increasing the oxidation of albuminous substances, as is shown by the increased quantity of solids in the urine. The iodides and bromides contained in some of these waters are usually present in such very minute amounts that it seems doubtful whether they contribute to their therapeutic action; and, at any rate, it is impossible to separate their effects from those of the sodium chloride.

The therapeutic indications of sodium-chloride waters, as based upon their physiological action, are sufficiently obvious. Their stimulant effects upon the mucous membranes have been utilized in the treatment of catarrhal processes, especially in the stomach and intestines. In chronic inflammations of the pharynx, stomach, duodenum, and bile-ducts, and in chronic intestinal catarrh associated with constipation, their use has been highly recommended. In congestive affections of the abdominal and pelvic organs, chronic endometritis, hepatic and splenic congestion, chronic inflammatory diseases of the respiratory tract, and in obesity, scrofula, and syphilis, they have also been employed with success, although their *modus operandi* in some of these conditions is not well understood. It is probable that their beneficial effect is attributable to the action of the saline in promoting osmosis and the absorption and excretion of inflammatory products.

Illustrative Comparative Chart of Saline Waters.

American.	European.	One pint contains—			
		Sodium Chloride.	Carbonic Acid Gas.	Temperature.	Other Prominent Constituents.
		grs.	cub. in.	Fahr.	grs.
	Homburg (Elizabeth-brunnen), Germany	79	48	50°	Chlorides of calcium and magnesium, 15; calcium carbonate, 11.
Ballston Artesian Lithian Well, New York.	. . . .	93	53	. . .	Magnesium and calcium carbonates, 34; potassium chloride, 4: lithium carbonate, 0.7.
	Wiesbaden (Koch-brunnen), Germany	52	17	155°	Chloride of potassium, 1; calcium carbonate, 3.
Hathorn Spring, Saratoga, New York.	. . . .	64	47	47°	Calcium and magnesium carbonates, 28.
	Bourbonne (Fontaine Chaude), France.	46	. . .	149°	Calcium chloride, 5; calcium sulphate, 6.
Congress Spring, Saratoga, New York.	. . . .	50	49	52°	Calcium and magnesium carbonates, 21; sodium bromide, 1.06.
	Kissingen (Ragoczi), Germany.	44	42	51°	Potassium chloride, 2: calcium carbonate, 8.
Kissingen Spring, Saratoga, New York	. . . .	42	45	40°	Calcium and magnesium carbonates, 26; sodium carbonate, 8; lithium carbonate, 0.64.
	Selters, Germany.	17	30	62°	Sodium carbonate, 6.
Saratoga Seltzer Sp'g, New York.	. . . .	17	. .	50°	Sodium carbonate, 2; calcium and magnesium carbonates, 10.

A large number of saline springs exist in America and Europe, a

very strong water of this kind being St. Catherine's Well, in Ontario, Canada, which contains about 275 grains of sodium chloride to the pint, and 125 grains of chloride of calcium. Its prototype in Europe is the celebrated Kreutznach Spring in Prussia, which contains about 110 grains of sodium chloride to the pint (Kurbrunnen). The following list comprises some of the best-known waters of this class:

Europe, France: Balaruc, Salies de Beárn, Salins.—*Germany:* Adelheidsquelle, Baden-Baden, Colbery, Dürrheim, Frankenhausen, Friedrichshall, Kreutznach, Kronthal, Nauheim, Niederbrunn, Pyrmont, Reichenhall, Soden, Sulzbrunn.—*Austria:* Gmunden, Hall, Salzburg.—*England:* Cheltenham, Leamington.—*Switzerland:* Bex, Rheinfelden.

America (*United States*), *Alabama:* Livingston Artesian Well, Sumter Co.—*Colorado:* Cañon Mineral Spring, Fremont Co.; Siloam Spring, Garfield Co.—*Indiana:* La Fayette Artesian Well, Tippecanoe Co.; Lodi Artesian Well, Wabash Co.; Ott's Well, Crawford Co.; Terre Haute Spring, Clay Co.—*Kentucky:* Blue Lick Springs (Upper and Lower), Nicholas Co.; Salt Sulphur Spring, Bath Co.—*Michigan:* Fruit Port Well, Ottawa Co.; Lansing Well, Ingham Co. —*Missouri:* Akesion Spring, Saline Co.; St. Louis Artesian, St. Louis.—*New York:* Albany Artesian Well, Albany; Ballston Springs (United States, Ballston Artesian Lithian Well, Franklin Artesian Well, Condo Dentoneau Well (which is the strongest lithia water extant), Ballston Spa), Saratoga Co.; Halleck's Spring, Oneida Co.; Saratoga Springs (High Rock, Red, Congress, Columbia, Hamilton, Washington, Putnam, Star, Pavilion, Empire, Excelsior, Seltzer, Union, Eureka, Geyser, Crystal, Champion, Kissingen); Syracuse Salt Wells, Oneida Co.—*Pennsylvania:* East Clarion Salt Spring, Elk Co.; Salina Spring, near Tarentum; Salt Spring, Bradford Co.; Salt Water, Indiana Co.—*West Virginia:* Borland Well, Wood Co.; Kanawha Spring, Kanawha Valley.—*Wisconsin:* Sheboygan Well.

Canada: Caledonia Springs, Ontario; Caxton Springs, Quebec; Sandwich Springs Ontario; St. Catherine's Well, Ontario.

Bitter or Purgative Waters.

This name has been applied to waters characterized by a high percentage of the sulphates of sodium and magnesium. They also contain considerable quantities of the sulphates of lime and the carbonates of lime and magnesium, and sometimes, though rarely, small amounts of carbonic acid gas. Carbonate of sodium, however, is seldom, if ever, found in them.

The chief physiological action of these waters is comprised in the stimulating effect which they exert upon the mucous membranes of the gastro-intestinal tract. They give rise to a profuse watery secretion of

a serous, or even mucous, character, and thus act as purgatives. If partaken of in large quantities, they frequently produce gastric and intestinal disturbances, and their protracted use is apt to be followed by atony of the intestines and intestinal catarrh. It is as yet a matter of speculation whether this purgative action is due to the increased exudation of fluids or whether it results from the stimulation of intestinal peristalsis, as is assumed by Flechsig and others. Owing to the increased peristalsis, the passage of food through the intestines is accelerated, and in consequence of the diminished absorption of nutriments engendered by this a loss of weight and disappearance of the fatty tissue result.

It follows from the above considerations that the use of these waters is restricted to cases in which we desire to stimulate the intestinal secretions, as in chronic constipation occurring in plethoric persons, engorgements of the abdominal and pelvic viscera, hæmorrhoids, etc. They may also prove serviceable in cases of obesity as part of a treatment of denutrition. On the other hand, their use is contraindicated in anæmic persons and where there is great irritability of the stomach and intestines, with a tendency to diarrhœa.

Illustrative Comparative Chart of Bitter Waters.

American.	European.	One pint contains—				
		Sodium Sulphate.	Magnesium Sulphate.	Carbonic Acid Gas.	Temperature.	Other Prominent Constituents.
		grs.	grs.	cub. in.	Fahr.	
	Püllna, Bohemia.	124	93	. . .	. .	Chloride of magnesium, 16; magnes. carb., 6 grains.
Crab Orchard, Foley's Sp'g, Ken.	. . . .	7	25	. . .	. . .	Calcic carbonate, 7; potassium sulphate, 1 grain.
	Friedrichshall, Germany.	41	39	5	46°	Sodium chloride, 67; magnesium chloride, 31; calcic sulphate, 11 grains.
Estill S'pgs, Irvine Sp'g, Kentucky.	. . . .	. . .	32	. . .	. . .	Calcic carbonate, 4; sodium chloride, 2 grains.
	Carlsbad (Sprudel), Bohemia.	19	. . .	8	162°	Sodium carbonate, 9; sodium chloride, 8 grains.
Bedford Springs, Pennsylvania.	. . . .	. . .	10	9	58°	Chloride of sodium, 1; calcium sulphate, 2 grs.
	Marienbad (Kreutzbrunnen), Bohemia.	36	. . .	15	53°	Sodium carbonate, 8; sodium chloride, 11 grains.
Harrodsburg Sp'g, Saloon Sp'g, Ken.	. . . .	. . .	28		. . .	Calcic sulphate, 10; sodium chloride, 1 grain.

The American waters of this class are somewhat weaker in sulphates of sodium and magnesium than the European, but the quantity of purgative salts present in the former is quite sufficient to produce active therapeutic effects. All these waters contain a considerable amount of sodium chloride, which contributes essentially to their physiological action. In the following list are given a number of bitter waters in Europe and America:

Europe, Germany: Mergenthlim, Grossenlüder.—*Bohemia:* Sedlitz, Saidschütz.—*Hungary:* Alap, Ofen (Hunyadi Janos, Franz Josef, Victoria, Arpad, Elizabeth).

America (United States), Colorado: Seltzer Spring, Boulder Co.; Pagassa Springs; Hot Springs, Cañon City.—*Georgia:* Catoosa Springs, Catoosa Co.; Indian Springs, Butte Co.—*Indiana:* Eaton's White Sulphur Springs, Crawford Co.—*Kentucky:* Bryant's Mineral Spring, Lincoln Co.; St. Louis Artesian Well.—*Michigan:* Midland Well, Midland Co.—*New York:* Avon Springs, Livingston Co.; Richfield Springs, Otsego Co.—*Ohio:* Green Springs, Sandusky.—*Oregon:* Beer Springs.—*Pennsylvania:* Bedford Springs, Bedford Co.—*South Carolina:* Glenn Spring, Spartanburgh Co.—*Virginia:* Blue Ridge Springs, Botetourt Co.

Sulphuretted Waters.

The constituent which gives these waters a distinguishing character is the sulphuretted hydrogen which they contain in greater or less amount. With it we find associated a varying quantity of sulphur combinations, such as the sulphides of potassium, sodium, calcium, and magnesium. They also contain the alkaline and earthy sulphates and carbonates, the chloride of sodium, and the sulphates and carbonates of iron, and these are frequently present in large quantities, and certainly play a not unimportant part in the therapeutic action of these waters. According to Daland, "a sulphur spring of moderate strength contains not less than 12 cubic inches of sulphuretted hydrogen in the gallon, though many springs contain so small an amount that therapeutically they are inert, and the good effects observed are due to the influence of the increased use of water, change of scene and climate, cessation of work, regular meals, good hygiene, and hope, all of which contribute strongly to restore health at all springs." Many of the sulphur waters are thermal and are chiefly employed in baths.

Nothing positive can be said regarding the physiological action of sulphur waters on the system. Various plausible theories have been proposed to account for their curative effects in the diseases for which they are employed. It seems probable that their chief action is exerted on the intestinal canal, where they stimulate the functions of the glands, increasing the secretions and producing laxative effects. When administered for a prolonged period they give rise to gastro-intestinal disorders and exert a debilitating influence upon the blood, heart, and lungs, as evidenced by anæmia, cardiac weakness, etc. According to Leichtenstern, the sulphuretted hydrogen absorbed into the blood is rapidly converted into sulphuric acid, and is therefore devoid of any specific effect unless present in very large amounts. On the other

hand, Stifft[1] concludes that the sulphuretted hydrogen has a specific excitant action upon the sensitive fibres of the pulmonary branches of the pneumogastric, and upon the respiratory, cardiac, and vaso-motor centres, its prolonged use giving rise to paralysis from over-stimulation. In this way he explains the action of the sulphur waters upon the respiratory and circulatory system, upon tissue-metabolism, and upon the secretory and excretory functions.

These waters have been administered internally in engorgements of the abdominal and pelvic viscera, especially in plethoric persons, in enlargement of the liver and spleen, hæmorrhoids, chronic intestinal catarrh, and chronic poisoning by metals. In the form of baths they have been recommended in gout and chronic rheumatism, but their curative effect in these cases is attributable to the elevated temperature of the waters, rather than to any specific action of the sulphuretted hydrogen or other constituents. At many baths the internal or local use of the waters is combined with inhalation of the gases or of the nebulized waters; and this method has been found useful in the treatment of chronic catarrhs of the pharynx, larynx, and bronchi.

The following chart illustrates the superiority of the sulphur waters of America:

Sulphuretted Waters (Illustrative Comparative Chart).

American.	European.	One pint contains—			
		Sulphuretted Hydrogen.	Sulphides.	Temperature.	Other Prominent Constituents.
		cub. in.	grs.	Fahr.	
	Neundorf, Germany.	1.28	0.55	53°	Calcium and magnesium sulphates, 10 grains.
Sandwich Spring, Ontario, Canada.	. . . .	4.72	. . .	52°	Chloride of magnesium, 19; calcium sulphate, 15 grs.
	Aix-le-Bains, France.	0.82	. . .	108°	Calcium carbonate, 1 grain.
Sharon Sp'gs, White Sulphur Spring, New York.	. . . .	2	0.28	48°	Calcium and magnesium sulphates, 24 grains.
	Harrowgate, England.	0.53	1.54	. . .	Sodium chloride, 86, potassium and magnesium chlorides, 10 grains.
Paroquet Spring, Kentucky.	. . . .	3.75	. . .	. . .	Sodium chloride, 39 grains.
	Meinberg, Germany.	0.61	0.67	48°	Sodium sulphate, 6 grains.
Salt Sulphur Sp'gs, Iodine Spring, W. Virginia.	. . . .	2.39	. . .	. . .	Sodium sulphate, 3; calcium sulphate, 8 grains.

The American waters of this class are more strongly charged with sulphuretted hydrogen than the European, and are especially numerous in New York and Virginia. In some places, as in Richfield Springs, provision is made for inhaling the gas or the finely-atomized waters. The following list contains a number of well-known sulphur springs in this country and in Europe:

Europe, France: Allevard, Ax, Baguères de Luchons, Barèges,

[1] *Die Physiologische und Therapeutische Wirkung des Schwefelwasserstoffes*, Berlin, 1886.

Cauterets, Eaux-bonnes, Eaux-chaudes, Enghien, La Preste, Saint Sauveur, Vernet.—*Germany:* Aix-la-Chapelle, Höhenstädt, Kreuth, Langenbrücken, Langensalza, Reutlingen, Taunstädt, Weilbach.—*Hungary:* Grosswardein, Trenezin-Töplitz.—*Switzerland:* Alberneu, Gurniglbad, Lawey, Lenk, Schinznach.—*Great Britain:* Moffat and Strathpeffer in Scotland and Llandindrod in Wales.

America (*United States*), *Alabama:* Blount Springs, Blount Co.—*California:* Calistoga Springs, Napa Co.; Paso Robles Hot Springs; St. Helena White Sulphur Springs, Napa Co.—*Georgia:* Red Sulphur Springs, Walker Co.—*Indiana:* French Lick Springs, Orange Co.; Indian Springs, Martin Co.; La Fayette Springs, Tippecanoe Co.; Lodi Artesian Well, Wabash Co.; West Baden Springs, Orange Co.—*Kentucky:* Estill Springs, Estill Co.; Louisville Artesian Well, Louisville; Olympian Spring, Bath Co.; Paroquet Springs, Bullitt Co.; Upper and Lower Blue Lick Springs, Nicholas Co.—*Michigan:* Alpena Well, Alpena Co.—*New York:* Avon Springs, Livingston Co.; Cherry Valley Springs, Otsego Co.; Chittenango Springs, Madison Co.; Clifton Spring, Ontario Co.; Columbia Springs, Columbia Co.; Florida Springs, Montgomery Co.; Longmuir Well, Rochester; Massena Springs, St. Lawrence Co.; Richfield Springs, Otsego Co.; Sharon Springs, Schoharie Co.—*Pennsylvania:* Minnequa Springs, Bradford Co.—*Virginia:* Augusta (Stribling) Springs, Augusta Co.; Buffalo Springs, Mecklenburg Co.; Greenbrier White Sulphur Springs, Greenbrier Co.; Jordan's White Sulphur Springs, Frederick Co.; Kimberley Springs, Bland Co.; Roanoke Red Sulphur Springs, Roanoke Co.; Yellow Sulphur Springs, Montgomery Co.—*Vermont:* Alburg Springs, Grand Isle Co.; High Gate Springs, Franklin Co.; Newburg Springs, Orange Co.—*West Virginia:* Red Sulphur Springs, Monroe Co.; Salt Sulphur Springs, Monroe Co.

Chalybeate Waters.

A large number of mineral springs contain the salts of iron, but the quantity present is frequently so small as to be practically devoid of therapeutic effects. In the class under consideration only waters containing a sufficient quantity of chalybeates to be of value in the treatment of disease will be mentioned. The iron salts usually occur in the form of the carbonate or sulphate. The other constituents, which are sometimes present in large amounts, are the alkaline carbonates and sulphates, the earthy carbonates, sodium chloride, alum, and sulphuric acid. Alum often exists in considerable quantities, especially in the chalybeate springs of Virginia. Chalybeate waters containing the carbonate of iron are clear, odorless, have a slight inky taste, and are highly charged with carbonic acid gas, which renders them palatable. They are chiefly employed for drinking purposes. The sulphate-of-

iron waters have a marked astringent taste, which sometimes proves an objection to their use, and their astringency may be decidedly increased by the presence of alum.

The physiological action of chalybeate waters is essentially similar to that of all iron compounds: they promote constructive metamorphosis, increasing the number of red globules in the blood and stimulating all the body functions. For internal use the waters containing the carbonate of iron are preferable, since they are less apt to disturb the stomach and are more easily assimilated, owing to the carbonic acid gas present. According to the character of the case it may be necessary to select an iron water containing alkalies, sodium chloride, sulphate of sodium and magnesia, or alum.

The chalybeate waters have been recommended in anæmia, chlorosis, and all conditions attended with anæmia, such as hysteria and neurasthenia, chronic endometritis, dysmenorrhœa, amenorrhœa, chronic gonorrhœa and spermatorrhœa, chronic affections of the kidneys, diabetes mellitus, chronic gastritis, nervous dyspepsia, chronic diarrhœa, etc.

Among the iron and alum springs, Bedford Alum Spring has been found remarkably efficacious in chronic diarrhœa, which had resisted both private and hospital treatment by the writer. The contraindications to their use, as given by Flechsig, comprise all febrile and congestive conditions and advanced organic diseases of the lungs, liver, and kidneys. The sulphate-of-iron waters are excellent astringents and disinfectants, and have been highly recommended in chronic diarrhœa, gastric ulcer, etc.

The following chart illustrates the superior quality of some American chalybeate springs:

Chalybeate Waters.

American.	European.	One pint contains— Sulphates of Iron.	Carbonates of Iron.	Carbonic Acid Gas.	Other Prominent Constituents.
	Brighton, England .	1.80	. . .	. . .	Calcium sulphate, 4 grains.
Church Hill Alum Springs, Virginia.	. . . .	19.8	. . .	. . .	Magnesium and calcium sulphates, 22; aluminium sulphate, 9 grains.
	Spa (Buhon), Belgium.	. . .	0.67	71.6	Small amounts of calcium carbonate and alumina.
Rock Enon Springs, Virginia.	. . . .	. . .	1.78	. . .	Calcium and magnesium sulphates, 2; calcium and sodium carbonates, alumina.
	Schwalbach (Stahlbrunnen), Germany.	. . .	0.46	50.2	Calcium carbonate, 1; manganese carbonate, 0.10 grain.
Vichy Springs, New Almaden, Cal.	. . . .	. . .	0.60	29.8	Sodium carbonate, 17; calcium carbonate, 3; magnesium sulphate, 1; sodium chloride, 4 gr.
	St. Moritz (Grande Source), Switzerland.	. . .	0.17	39.2	Sodium carbonate, 1; calcium carbonate, 6; sodium sulphate, 1 grain.
Estill Springs, Kentucky.	. . . .	. . .	0.23	4.15	Calcium carbonate. 1; magnesium sulphate, 1 grain.

The chalybeate springs of the United States differ from those of Europe especially in the large quantity of iron and alumina that many of them contain. The iron salt occurs in the form of a sulphate if free sulphuric acid is present, which is frequently the case. One of the most remarkable iron springs in the world is the Oak Orchard Spring in Genesee County, New York, which contains 10 grains of free sulphuric aeid to the pint. Of the numerous waters of this class in Europe and America, the following have been selected:

Europe, France: Charbonnière, Lamalon.—*Germany:* Alexanderbad, Alexisbad, Elster, Griessbaeh, Hermannsbad, Homburg, Koenig Ottobad, Liebenstein, Pyrmont.—*Bohemia;* Franzensbad, Königswart, Sangerberg.—*Hungary:* Szliaco (Josephsquelle), Bartfeld, Parad.—*Tyrol:* Mitterbad.—*Switzerland:* Tharasp (Wyquelle).—*England:* Cheltenham, Tunbridge Wells.

America (United States), California: Geyser Spa, Sonoma Co.; Napa Soda Spring, Napa Co.; Paeifie Congress Spring; Summit Spring, Alpine Co.—*Illinois:* Schuyler County Spring, Schuyler Co.—*Indiana:* Greencastle Spring, Putnam Co.—*Michigan:* Owosso Springs, Shiawasse Co.—*Mississippi:* Cooper's Well, Hinds Co.; Ocean Springs, Jaekson Co.—*New York:* Columbia Spring, Columbia Co.; Richfield Iron Spring, Otsego Co.; Sharon Chalybeate Spring, Sehoharie Co.; Oak Orehard Spring, Genesee Co.—*Pennsylvania:* Cresson Springs, Cambria Co.; Fayette Springs, Fayette Co.; Kittanning Mineral Spring, Armstrong Co.—*Tennessee:* Montvale Spring, Blount Co.—*Texas:* Thorp's Spring, Hood Co.—*Virginia:* Augusta Springs, Augusta Co.; Bath Alum Spring, Bath Co.; Bedford Alum Spring, Bedford Co,; Jordan Alum Springs, Rockbridge Co.; Orkney Springs, Shenandoah Co; Rawley Springs, Rockingham Co.; Rockbridge Alum Springs, Roekbridge Co.; Sweet Chalybeate Spring, Alleghany Co.—*West Virginia:* Fauquier's White Sulphur Spring, Fauquier Co.—*Wisconsin:* Sparta Artesian Well, Monroe Co.

Acidulous Waters.

These waters owe their therapeutic properties to the large quantity of earbonie acid gas they eontain, the solid constituents being present in only small amounts. As has been already stated, many alkaline and saline waters contain considerable quantities of this gas, but its effects, whatever they may be, are eompletely overshadowed by those of the mineral ingredients. In the acidulous waters, however, the earbonie dioxide is the chief therapeutic agent, and for this reason it beeomes necessary to discuss them as a separate elass of mineral waters.

The physiologieal action of earbonated waters is comprised in a gentle stimulant effect upon the mucous membrane of the stomaeh,

promoting peristalsis, and thereby a more rapid evacuation of its contents. The pulse and respiration are said to be slightly accelerated, and a larger quantity of urine is excreted. It seems however, that this diuretic effect is not attributable to the carbonic acid gas, as is assumed by some authors, but rather to the large quantities of water which the patient is able to imbibe without distress, for the quantity of the gas absorbed into the blood through the walls of the stomach is certainly too small to produce systemic effects.

The acidulous waters have been chiefly recommended in gastric disorders, especially those of neurotic origin, and owing to their agreeable taste they form excellent table waters. They relieve nausea, increase the appetite, and aid digestion. They have also been employed as baths on account of their stimulating effect upon the peripheral nervous system.

The following are examples of this class of waters:

Europe, Germany: Brückenau (Wernazer Quelle), Apollinarisbrunnen, Charlottenbrunnen, Neuenahr (Augustaquelle), Rienerz (Kalte Quelle), Schwalbach (Lindenbrunnen), Wildungen (Georg-Victorquelle).—*Bohemia:* Karlsbad (Dorotheenquelle), Liebwerda, Marienbad (Karolinenbrunnen).—*Styria:* Gleichenberg (Klausenquelle).

America, United States: Bladon Vichy Springs, Choctaw Co., Alabama; Blue Lick Spring, Maysville, Kentucky; Summit Soda Springs, Alpine Co., California; Sweet Chalybeate Spring, Alleghany Co., and Sweet Springs, Monroe Co., West Virginia; Clysmic Spring, Waukesha, Wisconsin.

Calcareous Waters.

These waters contain the sulphate and carbonate of calcium and the carbonate of magnesium, the calcium being the prominent constituent. They occur as cold and as thermal springs, and are frequently charged with carbonic acid gas. In a therapeutic sense they are of doubtful utility, and many authorities refuse them recognition as mineral waters. Although nothing is known of their physiological action, they have been highly recommended by Macpherson and others in gout, rheumatism, cystitis, uric-acid concretions, dyspepsia, chronic diarrhœa, etc. A number of characteristic waters of this class are given in the following list:

Europe, France: Contrexéville, Ussa, Vittel.—*Germany:* Wildungen, Driburg.—*Switzerland:* Vals, Weissenburg, Muri.—*England:* Bristol, Bath.—*Hungary:* Borszek, Szliacs.

America (United States), Michigan: Butterworth Springs, Kent Co.; Eaton, Rapid Wells, Eaton Co.; Leslie Well, Ingham Co.—*Ohio:* Yellow Springs, Greene Co.—*Pennsylvania:* Gettysburg Springs, Adams Co.—*Vermont:* Clarendon Springs, Rutland Co.—*Virginia:*

Alleghany Springs, Monroe Co.; Berkely Springs, Morgan Co.; Bethesda Springs.

Thermal Waters.

These waters owe their medieinal properties to their elevated temperature, which varies from 85° F. to the boiling-point. Owing to the considerable proportion of mineral and gaseous constituents contained in some of them, they have been mentioned among the other elasses: the majority of these waters are, however, defieient in solids, and aside from their high temperature may be regarded as therapeutieally indifferent. They have been ehiefly utilized for baths and reeommended in the treatment of ehronie rheumatism, gout, neuralgia, paralysis, chronic diseases of the skin, and syphilis. In all these diseases their effect differs in no essential degree from that of artificially heated water. It has been elaimed that the eontinuous and uniform temperature of mineral baths eonstitutes an element of superiority over the domestic baths; but this faetor is eertainly of slight importanee, and probably the environment contributes essentially to the cnrative effeets of thermal springs, as it does in the otheral mineral waters.

Below is given a list of thermal springs in Europe and Ameriea:

Europe, Germany: Aix-la-Chapelle (Kaiserquelle, 131° F.); Baden-Baden (Hauptquelle, 155.4° F.); Ems (Kesselbrunnen, 118.4°; Neuebadequelle, 122°); Karlsbad (Mühlbrunnen, 136° F.; Sprudel, 164.8° F.; Sehlorsbrunnen, 134.4° F.); Neuenahr (Mariensprudel, 101.75° F.); Sehlangenbad, 82.4°–89.6° F.; Warmbrunn, 104° F.; Wiesbaden, 155.6°; Wildbad, 94° F.—*France:* Aix-les-bains, 110.3°; Amèlie-les-bains, 141.8° F.; Bagnères de Luehon, 131.3° F.; Balaruc, 118.4° F.; Barèges, 111° F.; Dax, 140° F.; Mont Doré, 105.8° F.; Neris, 129° F.—*Italy:* Battaglia, 160° F.—*Austro-Hungary:* Baden, 96.8°; Gastein, 87°–160° F.; Grosswardein, 113° F.; Harkany, 144.5° F.; Töplitz (Hauptquelle, 120° F.); Warasdin-Töplitz, 134.6° F.—*Switzerland:* Leuk, 123° F.; Ragaz, 95° F.—*England:* Bath, 116.6° F.

America (United States): Arkansas: Hot Springs, Garland Co., 93°–150° F.—*California:* Calistoga Hot Springs, Napa Co., 100°–195° F.; Paso Robles Hot Sulphur Springs, Obispo Co. (Main Spring, 112° F.; Mud Spring, 122° F.); Santa Barbara Hot Sulphur Springs, Santa Barbara Co., 60°–130° F.—*Colorado:* Bath Spring, 103° F.; Chalk Creek Hot Springs, 130° F.; Hot Springs, Fremont Co., 95°–102° F.; Idaho Warm Spring, Clear Creek Co., 85°–115° F.; Middle Park Hot Sulphur Springs, Summit Co., 116° F.—*Georgia:* Warm Springs, Merriwether Co., 90° F.—*Idaho:* Hot Springs, near Boisé City, 196° F.—*Nevada:* Hot Springs, near Pyramid Lake, 208° F.—*New Mexico:* Hot Springs, Las Vegas Co., 123°–130° F.—*North*

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G. F. Crooke, Birmingham.
D. Drummond, Newcastle.
S. Delepine, Manchester.
J. Dreschfeld, Manchester.
Von Esmarch, Koenigsberg.
R. H. Fitz, Boston.
P. Grawitz, Greifswald.
W. S. Greenfield, Edinburgh.
H. Heiberg, Christiania.
Victor Horsley, London.
F. Hueppe, Prague.
J. W. Hulke, London.
O. Israel, Berlin.
E. H. Jacob, Leeds.
E. Klebs, Zurich.
Sir Joseph Lister, Bart., London.
O. Lubarsch, Rostock.
P. Marie, Paris.
E. Metchnikoff, Paris.
F. W. Mott, London.
E. Nocard, Alfort.
T. Oliver, Newcastle.
J. Orth, Göttingen.
T. Mitchell Prudden, New York.
J. F. Payne, London.
J. M. Purser, Dublin.
J. C. Salomonsen, Copenhagen.
A. M. Stalker, Dundee.
J. Burdon Sanderson, Oxford.
S. G. Shattock, London.
C. S. Sherrington, London.
J. Lindsay Steven, Glasgow.
H. Stilling, Lausanne.
I. Straus, Paris.
T. P. Anderson Stuart, Sydney.
R. Thoma, Dorpat.
J. Batty Tuke, Edinburgh.
L. Vaillard, Paris.
Rud. Virchow, Berlin.
H. Marshall Ward, Cooper's Hill.
C. Weigert, Frankfort a/M.
A. Weichselbaum, Vienna.
W. H. Welch, Baltimore.
Samuel Wilks, London.
A. E. Wright, London.
Von Zenker, Erlangen.
E. Ziegler, Freiburg.